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BENNINGTON COW CREAM JUG.

BENNINGTON DOGS AND TOBY.

A CHARLEY ROSS BOTTLE.

A PIKE'S PEAK BOTTLE.

A JENNY LIND BOTTLE.

A GROUP OF OLD AMERICAN BOTTLES.

TWO EXAMPLES OF NEW ENGLAND BOOK BOTTLES.

A CURIOUS COLLECTION OF BOTTLES.—[SEE PAGE 8.]

157568

THE ELECTRIC PIANO PLAYER.*

ITS DEVELOPMENT AND CONSTRUCTION.

BY JOHN F. KELLY, PH.D.

THE wonderful results obtained by the great masters of the art of piano playing ordinarily serve to disguise from us the simplicity of the means employed. This mechanical simplicity at an early date directed the attention of mechanicians toward seeking a substitute for the pianist's fingers. When a piano key is struck its hammer is thrown against the corresponding string, from which it immediately rebounds part way, and in this intermediate position it is caught and held until the key is released. The depression of the key simultaneously lifts the damper from the string. Both hammer and damper are therefore clear of the string while it is sounding. Nothing can be done to the key before the hammer is thrown, or after it is thrown and before the damper is returned, that can at all alter the tone produced. In any given instrument the pianist controls manually only the velocity with which the hammer strikes the string, and the return of the damper. The ordinary pedals add no new feature; they merely add to the ease of control. The wonderful art of piano playing is therefore built up by varying two simple elements.

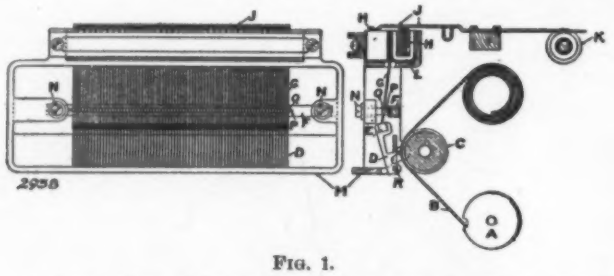


FIG. 1.

A, music-tape case; B, music tape; C, tracker roll; D, reading finger; E, ivory insulating block; F, contact bar; G, contact wire; H, resistance coil; J, comb wire; K, terminal; L, resistance coil frame; M, cradle casting; N, adjusting screws for contact bar; P, platinum strip and contact bar; Q, platinum bands on contact wires; R, swivel rod for reading fingers.

Froment appears to have attacked the problem as early as 1850, but the author has not been able to obtain any accurate account of this work. In 1861 a patent for an electric player was taken out in Würtemberg by Andre. In 1867 the celebrated mechanician Hipp exhibited an electrically operated piano which is worthy of some attention. It may be considered as the foundation of the work of the present day, and, indeed, in some respects it is in advance of much of the subsequent work. The Hipp apparatus consisted of two parts, a transmitter and a receiver. The latter consisted of a series of electro-magnets with armatures pivoted so as to swing toward and across the poles, and having the armatures connected by wooden rods with the jacks of the piano action. The transmitter employed a roll of perforated cardboard or cloth, similar apparently to the music rolls now so familiar, which was drawn by means of clockwork from one wooden roller to another. On its course it passed over a metallic roller and under a comb consisting of wires properly spaced and held in an insulating frame. The roller and the wires of the comb formed terminals of electric circuits including the magnets in the piano. The method of action is obvious. It is necessary to add that expression was controlled by the insertion of resistances in the common return. That he chose a type of magnet whose action could be modified in this manner is one of the evidences of Hipp's knowledge and careful work.

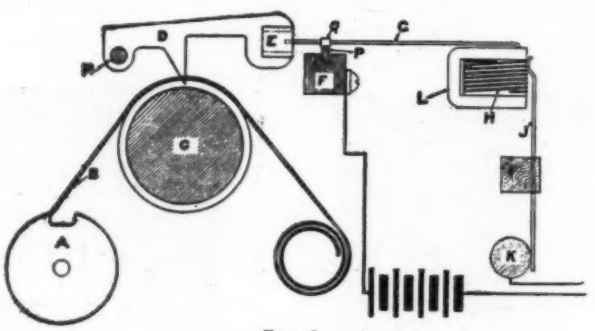


FIG. 3.

A, music-tape case; B, music tape; C, tracker roll; D, reading finger; E, ivory insulating block; F, contact bar; G, contact wire; H, resistance wire; J, comb wire; K, terminal; L, resistance coil frame; P, platinum strip in contact bar; Q, platinum band on contact wire; R, swivel rod for reading finger.

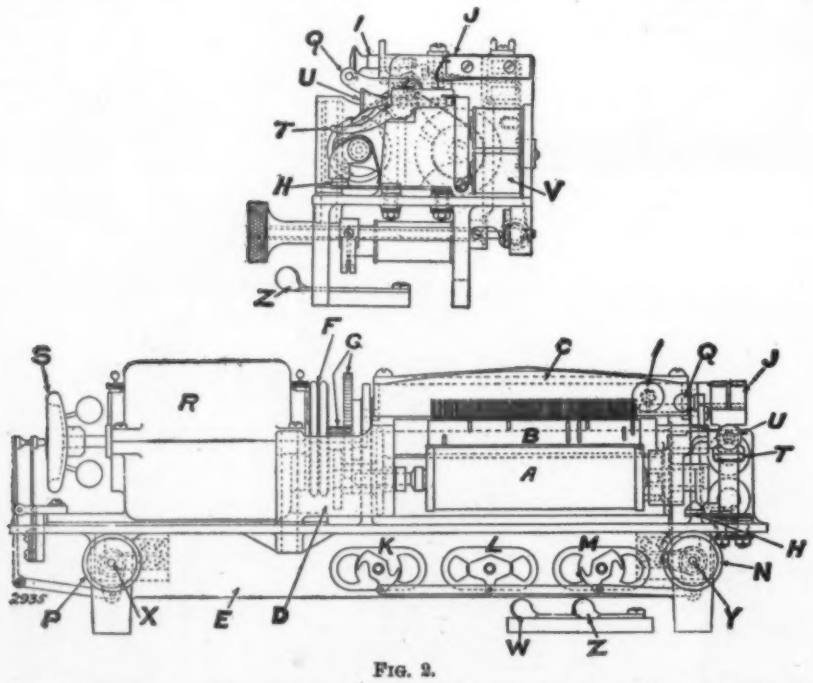


FIG. 2.

A, music-tape case; B, music tape; C, cradle; D, swinging carriage; E, base; F, rubber belt drive; G, gears; H, starting switch; I, expression cut-out knob; J, trip switch; K, forte expression magnet; L, medium forte expression magnet; M, piano expression magnet; N, expression handle; P, tempo handle; Q, carriage latch; R, motor; S, governor; T, lifting lever; U, trip button; V, trip magnet; W, bass subduing switch; X, sustaining pedal button; Y, soft pedal button; Z, treble subduing switch.

Another Swiss, Spiess, exhibited an electric player in Paris in the following year, 1868. So far as the description goes, this player seems to be substantially the same as Hipp's. We are more fortunate, however, in that we possess a contemporary statement as to the results obtained. The clearness and distinctness in rapid passages are the subject of special praise. It may be of interest to add that Hipp operated with ten Bunsen cells, and Spiess with thirty-six Daniell cells. To a considerable extent Hipp and Spiess must be regarded as being too far in advance of their time. The lack of a cheap supply of electric energy and the relatively small number of pianos in use would have precluded commercial success in any event.

At much about the same time as Hipp and Spiess, Prof. J. B. Webb and Mr. Oberlin Smith were at work on the problem in America. They sought to replace the perforated tape by one having the notes printed in metallic ink, and they tried also a conducting tape with the notes printed in insulating ink. Other work proved more attractive to both inventors, and they abandoned the piano player in an unfinished condition.

In the late seventies and early eighties William F. and Henry Schmoele of Philadelphia took out a number of patents relating to piano players. One of the patents described a music roll with the notes printed in metallic ink. The Schmoeles, who had on the whole a very clear idea of what a piano player ought to do, seem to have been deterred from the use of a straight electric action by the cost and unreliability of the supply of electricity at that time. They fell back on an electro-pneumatic action similar to that employed in playing organs from a distance, or, to compare their apparatus with what has now become more familiar, it resembled the present-day pneumatic action with the primary pneumatic replaced by an electric action.

At the Electrical Exposition of 1881 in Paris, Carpentier, the well-known instrument maker, exhibited a piano-playing apparatus which he called a repeating melograph. The name melograph had already been applied to an instrument exhibited in Vienna in 1873 designed to record piano playing. The complete Carpentier instrument was intended to cut a record of a composition played at the keyboard in the ordinary manner, and then to use this record as the music roll in the reproducer. In reproduction, which alone concerns us, Carpentier introduced a new idea. A shaft revolving at a fixed speed was placed under the keyboard. A number of brake shoes, corresponding to the keys to be operated and linked to them, were placed contiguous to the shaft, and pivoted so that a slight motion would apply them to it. When so applied the friction developed would pull down the piano keys with a force dependent on the speed of the shaft. The magnets controlled by the music roll, instead of operating the piano action, had only to throw the brake shoes against the rotating shaft. In this way it became possible to use smaller magnets and to economize in the use of electric energy, but unfortunately at the cost of losing control of expression.

Some dozen or more years later Carpentier's scheme was taken up by an American inventor, Mr. G. H. Davis, and embodied in a commercial machine. In the machine as now constructed Carpentier's cylindrical shaft has been replaced by one in the shape of the frustum of a cone with small apical angle. The chief

* Paper read at a meeting of the Franklin Institute.

improvement, however, is the addition of a hinged three-piece, soft-pedal bar, controlled by three levers. By means of this, expression may be imparted manually to music which, as controlled by the music sheet alone, would be perfectly flat.

Most inventors, however, have preferred to follow in the line marked out by Hipp. It has been shown that Hipp inserted resistance in the circuit with a view to varying the strength of the magnets, and so the intensity of the blow of the hammers. Although Du Moncel described Hipp as obtaining in this manner a satisfactory range from *forte* to *piano*, a little consideration will disclose an essential weakness in the

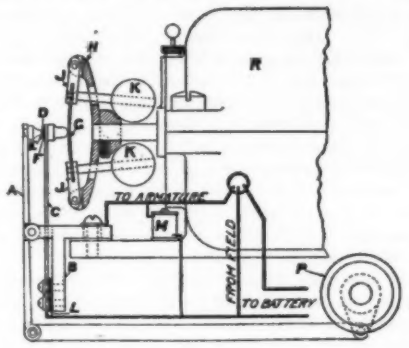


FIG. 4.

A, contact arm; B, governor bracket; C, follow spring; D, point of break; E, platinum point on contact arm; F, platinum point on follow spring; G, governor spring; H, governor disk; J, hinges for governor spring; K, governor balls; L, insulation block; M, shunt coil; P, tempo handle; R, motor.

scheme; any given resistance introduced into the main circuit will have an effect the greater the more magnets in circuit, a very undesirable result. Yet it was not until some thirty years later that it was shown that the true method is to insert a separate resistance in each branch circuit. Before condemning too severely the electrical inventors occupied with piano players for their slowness in discovering this point, it might be well to take into consideration that an analogous fault still exists in some of the pneumatic players of to-day.

In order, however, that insertion of resistance may give effective control of the magnetic pull, and hence of the touch on the piano keys, it is necessary that the magnets should be peculiarly constructed. It is necessary that the attractive force should be near its maximum when the armature first begins to pull on the piano action. When a magnet is employed in which the attraction on the armature rapidly increases as the armature moves toward the poles, it is practically impossible to control the movement by the control of the current. In such a case the current that is required to start the armature from its initial position suffices for a violent blow at the end of the path. Hipp perceived this, but it was overlooked by many of his successors.

Those who have had experience with pneumatic players know that one of the most serious difficulties with such instruments is the susceptibility of the paper music roll to atmospheric conditions. Naturally the same trouble is encountered when a paper roll is used in an electric player, and there are some new troubles. The fact that the paper is pulled between a wire comb and a rotating cylinder, instead of being drawn over a smooth tracker board, does not make for better tracking. And again, if the electric pressure be high, there is a tendency to burn the paper where it acts as a circuit breaker; while if it be low there may easily be uncertainty as to contacts.

In a series of patents running from 1901 to 1904 T. B. Powers, partly in collaboration with M. R. Jewell, has shown a player combination designed to overcome these difficulties. Powers's direct contributions are more important than those of any of his American predecessors, and he has also shown great talent in his utilization of the elements he took over from the prior act. His most important improvements are the substitution of thin metal tape for paper in the music roll, and the introduction of individual resistance coils in the branch circuits.

In 1905 the author acquired the Powers patents and organized the Telelectric Company to manufacture a player in accordance with them. Naturally in the course of manufacture many improvements in detail have been introduced, and some of great importance. It would be useless and wearisome to point all these out, but it will be of interest to describe the players now made, directing particular attention only to such changes as materially modify the musical results.

The apparatus in general plan recalls that of Hipp. The use of a metallic instead of a non-conducting roll has necessarily led, however, to a material change in the construction of the comb. In this instrument each of the elements of the comb consists of two parts—a reading finger proper, and insulated from this a wire acting as a contact maker. The contact is made with a separate contact bar instead of with the tracker roll, as in the Hipp apparatus. These elements, and a corresponding set of small resistance coils, are, in the standard sixty-five-note apparatus, set in a special frame, which, from its being pivoted in front to allow of a rocking motion, is usually called the cradle. The cradle is shown in Fig. 1, and its relation to the rest of the machine in the general view, Fig. 2. In Fig. 3 the construction and relation of the reading finger *D*, with its contact wire *G*, to the contact bar *F* and the resistance coil *H* are clearly indicated. The ivory block *E* serves to insulate the reading finger from the wire. It will be clear also from this figure that the metal music tape *B*, when unperforated, will lift the reading finger *D*, and so break the connection between the contact wire and the bar *F*. The wire *J* is one of a set forming a second comb serving to maintain connection between the resistance coils and the cable terminal *K*. When the cradle is rocked upward the resistance coil is raised, and, as an inspection of the figure will show, resistance is introduced into each circuit. This rocking of the cradle may be effected either automatically by means of the magnets shown at *K*, *L*, and *M* in Fig. 2, or manually by means of the handle shown at *N* in the same figure.

The winding and unwinding of the tape constituting the music roll are accomplished by means of an electric motor *R* provided with a governor *S*, Fig. 2. The transmission from the motor to the winding and rewinding rolls is through a pair of rubber belts and a set of gear wheels. The lifting of the tracker roller into place by means of the lever *T*, Fig. 2, puts the winding gear in mesh, while the lowering of the same roller shifts to the rewinding gear. This shift may be effected by pressing the button *U*, but ordinarily it is effected automatically at the end of the selection by means of the trip magnet *V*, Fig. 2. At the end of the music tape an opening is cut which allows a special reading finger to close the circuit of this trip magnet, thus dropping the tracker roller and shifting the gear.

With this instrument a governor must be provided. Not only must this maintain a steady speed, but it must maintain steady any speed the operator may choose. The simple make-and-break ball governor shown in Fig. 4 accomplishes this remarkably well.

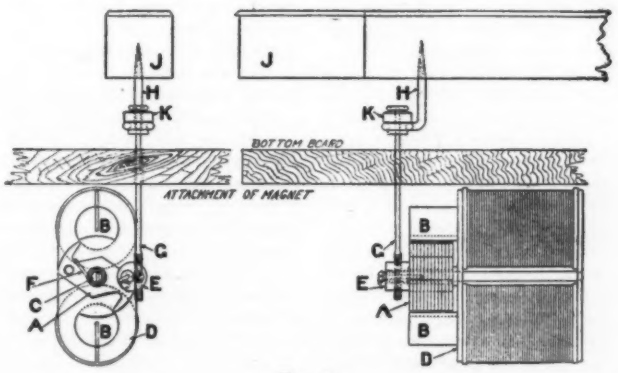


FIG. 5.

A, armature; B, poles; C, armature shaft; D, brass yoke; E, swivel; F, armature return spring; G, pull down wire; H, screw eye; J, piano key; K, rubber buffer.

The speed is varied by shifting the position of the contact arm *A* by means of the handle *P*, Fig. 4. This simple and absolute control is of special value in accompaniments. Because of it, it becomes easy for any singer to accompany himself.

Fig. 5 shows two views of one of the actuating magnets and the means of attaching the armature to the piano key. It will be observed that the rotary armature is so shaped and set with reference to the poles as to insure a strong initial attraction, which, as before pointed out, is necessary in order that the touch on the piano keys may be effectively controlled by varying the current in the magnet winding. A small screw eye is put into the key, the connection between this and the armature being made by means of a flexible steel wire. The eye of the screw carries a small rubber cushion to prevent any clicking from being developed by the wire striking against the screw. It will be observed that this method of connecting leaves the keys entirely free at all times, so that, for instance, one may play a duet with the electric apparatus as a partner.

Magnets similar to the key magnets, but larger, are used for operating the pedal bars. These magnets are controlled by perforations made at suitable points in the music tape, or they may be operated at will by the

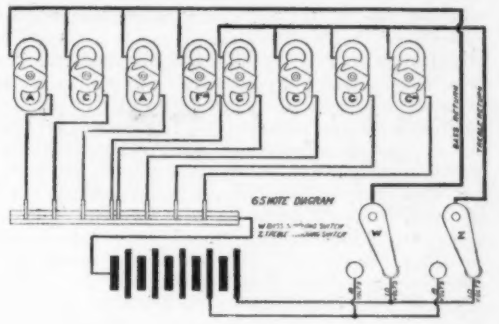


FIG. 6.

W, bass subduing switch; Z, treble subduing switch.

buttons *X* and *Y*, shown at the centers of the handles *P* and *N* in Fig. 2.

The music tape is a brass ribbon 5 inches wide and 0.003 inch thick. The perforations for the notes are arranged in a similar manner to those on the paper rolls, but on a much smaller scale. The brass is only one-third as long as the paper for the same music. That the same proportion is not exactly preserved in width is due to the fact that the brass tapes carry other perforations than those corresponding to the notes. Perforations, as stated already, are provided for controlling the action of the pedals, for varying the resistance in the circuit, and for shifting to the rewinding gear at the end of the selection.

The cutting of each selection is so arranged that the tempo of any selection will be normal for a fixed motor speed. This applies even to what may be called the normal variations from the standard tempo of the selection. Such variations are incorporated in the cutting. Variations in tempo to suit special tastes may be readily introduced by turning the handle *P*, Fig. 2, right or left, as may be required.

Apart from the variation in tempo, the means of obtaining expression so far described consist in the variable touch on the piano keys obtained by the use of variable resistance and the use of the pedals.

It will be evident from this description, therefore, that two distinct purposes have been kept in view in the building of the Telelectric player. On the one hand the attempt has been to build a machine which, when left to itself, will reproduce with perfect accuracy the music as written by the composer and with the proper interpretation. From this standpoint the music rolls are cut, carefully avoiding all "adaptations" to make it easier for the player, and all the peculiarities of interpretation of this or that virtuoso. For steady use and to meet the general cultivated taste, standard

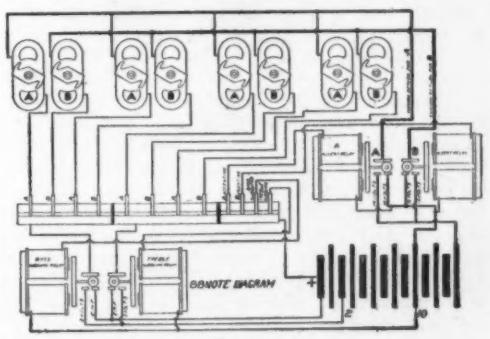


FIG. 7.

normal music is best, and music so cut forms the best basis for those who wish by manual control to obtain a personal interpretation. On the other hand, keeping in view this desire for a specialized or individualized interpretation, the instrument is provided with extremely simple means by which anyone with special tastes may vary the expression to suit himself.

Still further control of expression is of course desirable. In many cases a much improved effect is produced by playing bass and treble at different degrees of force. This is accomplished in a simple manner by dividing the magnets into two groups, so that two different electromotive forces may be simultaneously used. The electromotive forces may be varied by

means of the switches *W* and *Z* in Figs. 2 and 6. This improvement is incorporated in all the sixty-five-note standard players. If the author were to use the language of the piano-player advertising agent, he would describe this change as causing the accenting of individual notes and as bringing out the melody. This language is far too strong, and, like all exaggerated language, it is not only harmful in its direct untruth but it leaves one without terms to describe further improvements when actually made. Of course when the notes are thus divided into two groups all notes occurring simultaneously in either group are struck with equal force.

The musical advantage of a distinct individual accent is so great, however, that for two years the author has largely devoted his efforts to securing it, with the results that are shown in the eighty-eight-note player, Fig. 7. The simplest way to get an individual accent would be to practically duplicate the tape, using different electromotive forces on the parts. Imagine the music tape as made up of two parallel longitudinal bands, corresponding to a divided contact bar with a permanently maintained difference in potential. Imagine also the reading fingers, rheostats, and other accessories duplicated in each section, i. e., one wire from each section for each magnet and piano key. Then it will be clear that a note would be accented or not according to which section carried the corresponding perforation. Unfortunately the system calls for music rolls nearly twice the width required for non-accenting rolls, greatly increases the cost of the rolls, and is otherwise clumsy.

To keep the roll within reasonable dimensions, and at the same time obtain the requisite control over the force of the blow supplied to different keys, was the subject of much thought. The author became satisfied that some system of grouping the notes must be used, and worked out several plans for the control of the groups. These plans, with the exception of that now being introduced into practice, it is unnecessary to describe. As to the grouping, the first idea that presented itself was, instead of simply dividing the scale into bass and treble, to cut it up into numerous sections. It would thus be possible to confine the accent within a narrow section. Unfortunately, until the section is reduced to the compass of but a single note it is always possible that it may contain a note which it would be undesirable to accent. Indeed, the narrower the section the more important it is that it should not contain a second accented note. The next idea that presented itself was to include in each group only notes of the same name: C's in one group, C-sharps in another, and so on to the end of the scale. This is very much more satisfactory. Even if two notes should happen to be sounded in one group, as would occur sometimes, so that both might catch the accent, as the two are consonant, the effect would be substantially that of accenting the single note. Indeed, with the old-fashioned player the accenting of a note can often be simulated by cutting its octave to sound with it. The author thought it desirable, however, to go further than this, and on this octave grouping he superimposed the division into bass and treble. In consequence of this double grouping it is possible to obtain four different strengths of blow on the piano keys simultaneously. This capability, added to the power of control over expression already described, ought to satisfy the most exacting requirements.

The arrangements for carrying out this method are clearly shown in the diagram, Fig. 7. The key-operating magnets are from one end of the circuit divided into two groups, and from the other end into twelve. The source of electromotive force has four terminals, ordinary 0, 2, 10, and 14 volts. Switches are so arranged that the wires leading to the magnets on the one side may be connected either to the 0 or the 2-volt terminal, and on the other to either the 10 or the 14. These changes are independent of each other. It is therefore possible to supply any magnet with 8, 10, 12, or 14 volts at will. The switches are operated by quick-acting electro-magnets, and these, in turn, are controlled either by special perforations in the music-roll, or at will by the operator through specially provided buttons. At the will of the operator, also, any one or more of the means of expression may be left music-roll-controlled while he manually controls the rest. He may pick out that portion of the expression in which he feels he can best express his individuality, leaving the rest of the machine, or he may take entire control and make the expression entirely his own.

A word as to the future. It would seem that the idea is still prevalent that a piano player must be necessarily inartistic. Logically, those who hold this idea should condemn the piano also, for piano playing is but mechanicalized harp playing. In all arts and crafts alike there is, and always will be, a place for hand work. Pioneer work falls to the hand, and in the arts especially there is a peculiar grace arising from the flexibility of the instrument. But power, accuracy, and precision are the features of the machine. The grace of the harp, and the fact that it allows of a more highly individualized playing, have in no wise prevented the more mechanical piano from becoming a hundred times more common, and the favorite instrument of great artists. And while, as in passing from the harp to the piano, so in passing from the simple piano to the piano and player, there may be in some respects a loss, it would seem that for this loss there is a more than equivalent compensation; in speaking of compensation the author has in mind not only that thousands are reached by the player who otherwise would be deprived of all good music, but also that to some extent there are direct artistic compensations. While the piano mechanism restricted the performer in some directions as compared with that of the harp, in others it opened out to him a wider field. And the player in turn will again widen the field. The composer will no longer have to think of the limitations of ten fingers on two hands. Consider what this may mean in transcriptions of orchestral music, or, if we have the daring, let us even dream of what it may mean in original piano music. There is another reason why our ultra-artistic piano lovers should take a more generous attitude toward the player. The growth of the piano trade, if it did not actually hinder the making of harps, at least did nothing to advance that art. The piano-playing business, on the other hand, tends to enormously increase the number of pianos in use, and each of these pianos should be recognized as the possible means of development of a future artist. And surely the struggling musician will be none the less likely to develop into an artist because he has at his disposal a machine which will make it possible for him to hear the great music of the world. As well might we say that it would be harmful to a young painter to be placed in possession of a set of photographs of the world's masterpieces in painting.

THE NEW AUTOMOBILE STEELS.—II.

THEIR USE IN MOTOR-CAR CONSTRUCTION.

BY JOHN A. MATHEWS, PH.D., SC.D.

Concluded from Supplement No. 1747, page 411.

CASE-hardened vs. Oil-hardened Gears.—In the automobile trade there have existed two schools, so to speak, one believing in the case-hardened type of gear and the other in the oil-hardened type. As previously mentioned the chrome-vanadium, chrome-nickel, and silico-manganese alloys are made in both high and low carbons. The former contain about 0.45 to 0.60 per cent carbon, and enough other hardening elements so that by merely quenching in oil from a bright red heat a surface-hardening is produced sufficient for ordinary wearing purposes while the hardness does not penetrate deeply into the gear but leaves a core that is tough and strong. The low carbon alloys, with about 0.20 per cent carbon, require to be carbonized or case-hardened in order to produce sufficient surface-hardening for wearing purposes after hardening. The speaker's word on the merits of gears made by these two methods will hardly be accepted as final, as he is not an authority upon gears. Several years of observation and contact with the trade, however, leads me to prefer the case-hardened gear. The result of direct tests upon thousands of gears of both types leads me to the following conclusions: (1) The static strength of a case-hardened gear is equal to that of an oil-hardened gear, assuming in both cases that steel of the same class and appropriate analysis has been used and that the respective heat-treatments have been equally well and properly conducted. (2) Direct experiments proved that the case-hardened gear resists shock better than the oil-hardened. (3) As regards resistance to wear the same type is incomparably better, although perhaps not as silent in action.

One of the leading makers of gears has proved this to his own satisfaction of late by an arrangement of shafts and gears whereby energy is transmitted through two case-hardened gears, in mesh with each other, to two oil-hardened gears. The gears are of the same size. Five sets of oil-hardened gears have been worn out while the original case-hardened gears are still in service and show the tool marks.

Upon the part of many there is strong objection to case-hardening. In nine cases out of ten this is doubtless due to the fact that the case-hardening operation has not been reduced to a science. The depth of case, the relation of case to core, the time and temperature to produce certain results, and the exact control of these conditions, together with an accurate knowledge of the material to be treated, are the factors that enter into successful case-hardening practice. Further points in favor of this method are easier machining of the blanks, and at least equal static and dynamic properties with less chance of injury in hardening.

While considering gears, we may as well dip in a little deeper and consider the relative merits of gears cut from bars and from drop-forged blanks. Parts like spur gears, bevel pinions, and many shafts may either be drop-forged or cut from bars in automatic machines. Contrary to general opinion many parts can be machined out of bars as cheaply as they can be from forgings. Moreover, I am firmly of the opinion that no steel is improved physically by drop-forging, some steels, of course, being less susceptible to injury than others. In good steel mill practice great attention is paid to proper finishing heats, and steel is brought gradually to size. In drop-forging work, in order to give sufficient plasticity to assume various forms in dies, it must be heated very hot. It is then frequently formed with the fewest possible blows. An investigation of drop-forged and bar-cut gears, the former being the product of one of the foremost drop-forging companies, showed that under static test the bar-cut gears, as the average of many tests, were fully 25 per cent stronger, and their resistance to shock test was also much better, but the difference cannot be exactly stated in percentage. The fact that the static test did not show more than 25 per cent average superiority for the cut gear was a surprise to me and speaks well for the forging concern in question. In many cases, I fear a larger difference would be found. It is just such points in the construction of various makes of cars of the same general design that would be of the greatest benefit to the would-be purchaser.

To show that case-hardening is a science, let me quote from Dr. Guillet once more. In reference to the proper procedure in case-hardening he says: "As is well known, the operation of case-hardening consists of placing a steel in some medium capable of imparting carbon to it, at a suitable temperature; after a sufficient interval a steel is obtained the interior of which possesses the same percentage of carbon as before case-hardening, but the exterior of which is much higher (0.80 to 1.00 per cent). On quenching such a steel an extremely high degree of mineralogical hardness is obtained on the surface, while the center of the piece is non-brittle, if, that is, the operation has been properly carried out. One generally uses steels containing 0.10 to 0.25 per cent of carbon for case-hardening. In order to avoid all brittleness in the interior and exterior of the piece, and, at the same time, to obtain a high degree of superficial hardness and a very regular degree of carburization (in carbon steels) it is necessary—

1. "To use a steel containing less than 0.12 per cent of carbon, and with a low percentage of manganese (less than 0.30 per cent) and—

2. "To case-harden with a chemically definite material such as a mixture of 60 parts charcoal and 40 parts of barium carbonate at a temperature between 850 deg. C. and 1,050 deg. C.—the higher the temperature the more rapid the case-hardening—and allow it, after the operation, to cool down just below the transformation point (about 600 deg. C.).

3. "To reheat the piece and quench it at 900 deg. C. (just above the transformation point of the center), this operation having the effect of rendering the center fibrous."

This operation has the effect of toughening the center but the outside will be coarse-grained and brittle. The next operation, according to Guillet, is—

4. "To quench for a second time at 800 deg. C. (above the transformation point of the exterior), to render the skin non-brittle.

*Journal of the Franklin Institute.

"In any case, the methods by which it is possible to obtain, with low-carbon steel, case-hardened pieces which shall not be brittle, are exceedingly delicate."

How different this is from the operation one too often sees, where the pieces are dumped directly from the case-hardening boxes into water. However, if one uses a good grade of nickel steel, low in carbon, and case-hardens at appropriate temperatures, and then takes the precaution to cool off in the boxes before heating for quenching, and then hardens at about 800 deg. C., the results will be fully equal or better than can be obtained by the most careful handling and double quenching of carbon steels. The saving in cost of the operation can be applied toward the greater cost of nickel as compared with ordinary case-hardening steel.

Better still, however, if nickel steel is used, is to give it a double quenching, too, then one obtains a really admirable product of extraordinary toughness, and remarkable wearing qualities. An ideal way of making a nickel-steel gear consists in first annealing the blank, then rough-machining approximately to size, then giving a light reannealing before taking the last finishing cut. Then pack in suitable mixture and carbonize to a depth of 1/64 to 1/32 of an inch, according to requirements, at a temperature of about 1,625 deg. to 1,650 deg. F. Cool in the pots, heat to about 1,500 deg. F. and quench in a hot brine or calcium chloride solution. This will put the core into excellent physical condition. Finally, reheat to 1,375 deg. to 1,400 deg. F. and quench in oil. This last operation will refine the grain of the case and harden it with best results. The temper need not be drawn.

It will be noticed that the temperatures for treating nickel steels are considerably lower than those advocated by Guillet for carbon steels.

If methods like these are followed it is not likely that a very great difference would be noted between bar-cut gears and gears cut from drop-forged blanks. In the case of medium carbon gears not to be case-hardened but oil-hardened only, one would probably find a greater difference and in this case we have no opportunity to restore the over-heated forged blank by scientific heat treatment. This, in addition to the greater chance of over-heating, and the greater difficulty of machining, also favors the use of case-hardened gears, assuming, of course, the case-hardening is to be skillfully done.

In conclusion, let me bring to your attention certain facts and considerations with reference to springs and spring making. There are in general two kinds of springs used in automobiles, coil and flat springs. The latter may be full, three-quarter, or half elliptic. From observation and general report it appears that the general maker of springs has not kept pace with the improvements in spring-steel, and with the increased severity of the duty expected of springs. With many of them to suggest a change of method is like preaching heresy in a theological school.

The new steels cannot be handled just like the old ones and still obtain from them the maximum development of their powers. However, the new steels, being in general lower in carbon, will stand much abuse in heat treatment, and still produce springs of quality undreamed of a decade ago. But how foolish it is to pay four or five times the cost of regular spring steel and then not adopt methods to develop its maximum excellence even to an increased endurance of a hundred fold over plain carbon spring steel!

While as a class spring makers may have been driven to the use of alloy steels, they have not as a class been forced to handle them scientifically. I am happy to say there are a few exceptions to this and I hope their number will increase. The old practice of forming and hardening springs with a single heating cannot be persisted in if maximum quality and service are to be secured.

Satisfactory tests on flat springs are somewhat difficult to make but in coiled springs quality can be easily shown and the relative merit of different steels demonstrated. The most satisfactory test is to operate the springs—open and close—by some sort of repetitive impact method until destroyed. In order to produce results in a reasonable length of time the duty must be severe, and the rate of alternations of stress rapid. The number of alternations of stress to produce fracture gives a measure of its vitality, so to speak.

The average results of a great many tests made in this way of crucible carbon springs, chrome nickel, silico-manganese, and genuine crucible chrome-vanadium springs prove the extraordinary quality of the last-named product, and the antifatigue qualities imparted by vanadium. The average figures for alternations were as follows: crucible carbon spring, 125,000; chrome-nickel and silico-manganese, each 200,000; crucible chrome-vanadium, 5,000,000, and still unbroken. This, then, is the panacea for all valve, clutch, break, and flat spring troubles. The engineer of a company which makes a very heavy car and uses a semi-elliptic spring told me recently that they had not had a leaf to break or a spring to sag since adopting crucible chrome-vanadium springs made by an up-to-date spring-maker. Prior to this time they were in trouble all the time.

The tempering of this steel is quite simple. The springs should be heated to 1,675 deg. to 1,700 deg. F., and quenched in oil. The temper is then drawn according to the nature of the spring and the duty expected. The drawing range is very wide, namely, from 600 deg. to nearly 1,000 deg. F. In the line of spring-steel this product has my profound admiration.

In what I have said this evening I have tried to impress upon you the importance of using high-class materials when severe duty is demanded, of using discrimination in the selection of special steels for special work, of looking beyond the first cost of your raw materials, and of studying the fascinating subject of heat-treatment. If I have succeeded in a measure in this, our evening will have been well spent. If I have caused any of you to think more deeply on these subjects or have made any one's conscience hurt him just a little bit because of past neglect, or have offered any practical suggestions which you can apply in your daily work to the betterment of your product, then I shall not regret having accepted the invitation to address you upon this important subject.

APPENDIX.

In presenting some tables showing typical analyses, treatments and tensile tests of nickel, nickel-vanadium, chrome-nickel, and chrome-vanadium steels, we have drawn upon many sources of information, as, for example, the data published by the American Vanadium Company, experimental data upon tests made by the writer, and commercial tests made upon the steels of many makers. The temperatures when given are approximately correct. In giving analyses only the essential elements have been given. We have expressed the elastic limits and tensile strength in net tons per square inch, and the elongations are as measured upon a 2-inch test specimen ½ inch in diameter.

TABLE 1.—NICKEL STEELS.

No. of Tests.	C.	Mn.	Ni	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
4	.21	.86	3.48	....	....	68	112	13.7	45	1550 F. oil 600 F.
4	.25	..	3.50	....	....	85	109	13.4	..	1550 F. oil 600 F.
2	.27	..	3.50	....	....	86	110	13.3	51	1550 F. oil 600 F.
30	.18-.28	.60-.90	3.5	....	....	68	103	12.9	54	1550 F. oil 600 F.
11	.18-.28	.60-.90	3.5	....	....	84	116	12.4	48	1600 F. brine.
4	.25	.60-.90	3.5	....	....	88	121	12.3	48	1600 F. brine.
7	.23	.61	3.54	....	....	103	114	14.0	50.7	1550 F. water 212 F.
1	.14	.63	3.89	....	....	76	88	15.0	54.6	1300 F. water 212 F.
1	.14	.63	3.64	....	....	30	41	33.5	72.4	1400 F. oil 1200 F.
4	.35	.45	3.39	....	....	77	84	15.5	55.5	1500 F. water 900 F.
4	.35	.45	3.39	....	....	130	137	10.0	38.3	1500 F. water 430 F.
3	.25	.86	3.45	....	....	31	45	31	60	Natural, as rolled.

TABLE 2.—NICKEL-VANADIUM STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
1	.34	.17	3.88	....	....	29	43	27.3	54	Natural as rolled.
1	.33	.16	3.72	....	.12	41	54	23.8	53	Natural as rolled.
1	.33	.16	3.40	....	.24	49	66	17.8	40	Natural as rolled.
1	.34	.17	3.88	....	....	37	51	16.5	51	1500 F. oil 1150 F.
1	.33	.16	3.72	....	.12	51	59	24.0	61	1500 F. oil 1150 F.
1	.33	.16	3.40	....	.24	59	62	21.0	61	1500 F. oil 1150 F.
1	.34	.17	3.88	....	....	39	66	15.5	55	1500 F. oil 600 F.
1	.33	.16	3.72	....	.12	70	76	14.5	56	1500 F. oil 600 F.
1	.33	.16	3.40	....	.24	82	85	15.0	55	1500 F. oil 600 F.
1	.24	.72	3.33	....	.12	38	49	27.0	64	Natural as rolled.
1	.24	.72	3.33	....	.12	71	100	11.6	36	1600 F. oil.
1	.24	.72	3.33	....	.12	92	117	14.5	52	1600 F. water.
1	.24	.72	3.33	....	.12	91	116	15.2	57	1600 F. brine 400 F.

These tables are given to illustrate the tremendous possibilities of careful heat treatments, and in some instances they illustrate the danger of applying wrong treatments. The effect of variable carbon contents in alloys of the same type is illustrated, and varying qualities that may be obtained from the same alloy by different treatments may be observed.

One point I must mention in connection with these tests is, that in designing parts one must be very cautious not to be misled by the remarkable tests yielded when a standard test piece is tested, and to use these figures as a guide to the physical qualities likely to result when a much larger mass of metal is treated. Because a ½-inch test piece oil-tempered and annealed gives an elastic limit of 75 tons per square inch, it does not follow that a 1½-inch diameter bar similarly treated will yield the same elastic. The hardening action in quenching does not penetrate very deeply in a large bar, while in a small one it may penetrate to the center.

The writer once made a quantitative experiment upon this point, using a 0.43 carbon steel, containing vanadium. The steel was in the form of an inch-round rolled bar. In one case I oil-tempered a full inch section of the bar at 1,600 deg. F. and annealed it at 1,030 deg. F., and from this machined up a test piece. In the other case, I made the test piece from the inch-round bar, and having reduced it to a half-inch diameter test piece, subjected it to the same treatment as I had applied to the full-sized bar. The piece treated in the form of a test piece gave me 42.5 tons elastic limit, 58 tons tensile, 21.5 per cent elongation, and 58 per cent reduction. The other piece was over 4 tons lower in elastic limit; over 3 tons lower in tensile, and 2.2 per cent and 3.6 per cent higher in elongation and reduction respectively. This shows that while it may be quite possible to obtain an elastic limit of 100 tons in a thin spring, one would not have the same elastic by the same treatment had the same steel been made into a massive gear.

Many of the figures given in the tables are the averages of several tests made upon materials of the same general kind, and in the first column of the tables is given the number of tests, either average or single, upon which the figures are based.

In the column marked "treatment" is given the temperature to which the steel has been heated, followed by the liquid in which it was quenched, and then by the temperature to which it was reheated to draw the temper or anneal. This will make clear such terms as 1,600 deg. F.—oil—600 deg. F., etc.

TABLE 3.—CHROME-VANADIUM STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A.	Treatment.
3	.26	.39	....	.78	.17	44	68	20	64	Natural as rolled.
1	.26	.39	....	.78	.17	103	139	3	8.2	1570 F. oil 400 F.
3	.27	.50	....	1.00	.17	33	45	28	62	Annealed 1475 F.
1	.27	.50	....	1.00	.17	52	63	21	56	Oil tempered and drawn to various degrees.
1	.27	.50	....	1.00	.17	62	65	17	60	
1	.27	.50	....	1.00	.17	70	74	17	57	
1	.27	.50	....	1.00	.17	100	106	12	51	
1	.27	.50	....	1.00	.17	112	116	11	39	
1	.40	.77	....	1.22	.19	34	50	26	62	Annealed.
1	.40	.77	....	1.22	.19	98	104	10	36	1650 F. oil 840 F.
1	.30	.50	....	1.00	.16	71	76	16	56	1650 F. oil 1025 F.
3	.38	.73	....	1.19	.18	41	65	22	67	Natural as rolled.
1	.38	.73	....	1.19	.18	110	144	10.8	47	1660 F. oil 600 F.
1	.38	.73	....	1.19	.18	64	113	21.9	53	1660 F. oil 850 F.
1	.33	.54	....	1.24	.20	64	72	15.5	56	1500 F. oil 1125 F.
1	.33	.54	....	1.24	.20	95	104	11.0	38	1600 F. water 600 F.
5	.45	.56	....	2.37	.30	88	94	13.2	46	1600 F. oil 1125 F.
4	.45	.56	....	2.37	.30	138	146	6.0	16	1600 F. oil 430 F.
1	.36	.21	....	2.78	.24	60	104	4.1	88	Natural as rolled.
1	.36	.21	....	2.78	.24	65	72	20	56	1500 F. oil 1150 F.
1	.36	.21	....	2.78	.24	98	104	13	45	1500 F. oil 600 F.

TABLE 4.—CHROME-NICKEL STEELS.

No. of Tests.	C.	Mn.	Ni.	Cr.	V.	E. L.	T. S.	Elong. in 2".	Red. in A. P.	Treatment.
1	.37	..	2.9	1.04	....	60	78	18.5	61	1475 F. oil 1300 F.
4	.37	..	2.9	1.04	....	77	84	16.	56	1500 F. water 1100 F.
1	.45	..	2.0	1.0	....	70	90	8.0	20	Oil-temp. and annld.
1	.25	..	2.0	1.0	....	50	65	12.0	30	Oil-temp. and annld.
2	.25	..	3.0	1.5	....	57	64	15.0	65	Annealed
1	.25	..	3.0	1.5	....	116	116	6.0	40	Hardened—oil.
1	.50	..	2.0	1.0	....	33	46	27.0	64	Natural as rolled.
3	.50	..	2.0	1.0	....	72	134	6.0	23	Tempered.
1	.30	..	2.0	1.0	....	35	53	18.0	45	Natural as rolled.
1	.30	..	2.0	1.0	....	88	98	9.0	37	Tempered.
1	.30	..	2.0	1.0	....	45	55	25.0	55	Oil-temp. and annld.
1	.40	.18	2.1	.80	....	60	76	12.8	37	Natural as rolled.
1	.40	.18	2.1	.80	....	58	66	17.5	40	1500 F. oil 1150 F.
1	.40	.18	2.1	.80	....	106	118	10.0	34	1500 F. oil 600 F.
1	.40	.18	2.1	.80	....	70	79	15.5	48	Annealed 1150 F.

THE ACTION OF SEA WATER ON CEMENT CONCRETE.

IN the Journal of the Society of Chemical Industry, C. G. Potter presents his researches on the action of sea water on cement concrete.

As a result of trying various methods of overcoming the failure of Portland cement concrete by softening and expansion which occurs in a very few years or less in sea water, Mr. Potter was successful when calcined red-brick clay was added to the clinker while grinding. Six parts of clay to 10 of cement by weight give the best all-round results, and thorough mixing and fine grinding are necessary. A variety of test results extending over periods up to ten years are given. For at least a few weeks after making, the "red" cement mortar is weaker than the Portland, but in the course of time the strength of Portland, kept in sea water, falls to zero, while that of the red is maintained or increases. As is known, the failure of Portland is due to the presence of about 0.25 per cent magnesium sulphate in sea water. Precipitated magnesia is found in the fracture of blocks of Portland cement concrete which have been exposed to sea water. The destructive action occurs rapidly in sea water to which has been added 10 per cent of magnesium sulphate. In this solution neat Portland cement has a strength of 500 pounds per square inch in one month, and *nil* after one year's immersion. Red cement gradually continues to gain strength, just as Portland cement does in fresh water. The greater the proportion of sand in Portland cement mortar, the more rapid its failure in sea water, owing apparently to its greater porosity allowing more ready access of the solution. The strength of the red cement samples kept in sea water was rather higher than in fresh water. Some results of tests are also given which show that if Portland cement mortar be exposed for some time to the action of a CO_2 atmosphere before exposure to sea water, the action of the sea water upon it will not be so serious as if exposed to sea water immediately. Exposure to CO_2 of "red" cement mortar also increases its ultimate strength in sea water.

Labarthe's Washing Powder.—48 parts ammonia-soda, 6 parts potash (75 to 80 per cent), 8½ parts caustic soda (70 per cent), 36 parts soda water-glass, 1 part permanganate of potash, ½ part oil of thyme. This powder is for use for linen. For woolen articles add soap bark. It must be remembered that all water contains more or less iron in solution. If ever so little is present, its presence will be revealed in the washing in the course of time. This and other causes will contribute to its gradual acquisition of a yellowish tint and it must then be subjected, in some way or other, to a bleaching process.

A CURIOUS COLLECTION OF BOTTLES.*

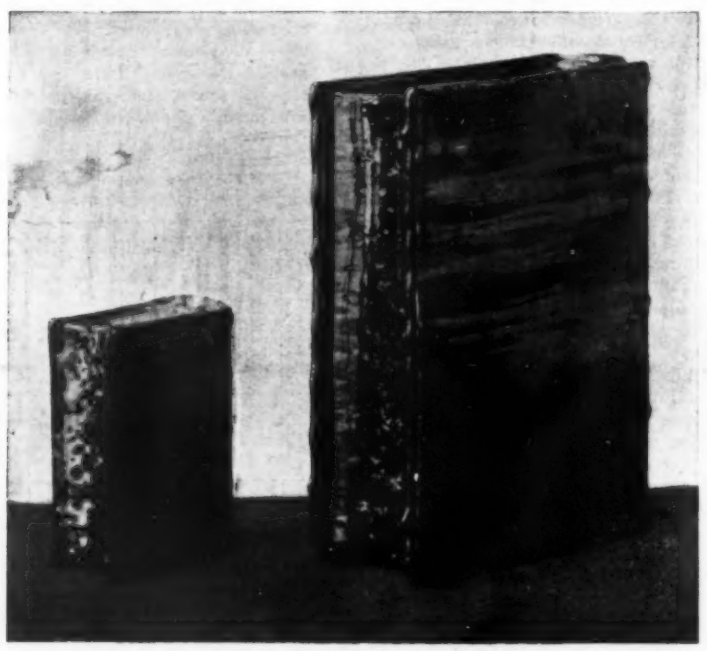
RELICS OF A BYGONE INDUSTRY.

BY ADA WALKER CAMEHL.

AMONG the numerous fads and fancies of the house furnisher of to-day none is more quaint and interesting than the decorative use of the vari-colored bottles and flasks of many shapes and sizes, which are relics of one of the oldest enterprises of our country. These bottles are found in a great variety of color, ranging from dark browns, blues, and reds to lighter shades of olive, russet, claret, emerald green, pale blue, and transparent white. When grouped upon a tall mahogany sideboard or table, and placed so that the sunlight falls upon them, they form a rich and effective mass of decoration.

The shapes of these bottles are many and curious. They are tall bottles with long necks and fat bodies, short squat bottles with scarcely any necks at all, bottles with ribbed edges and bottles with plain edges. Each manufacturer had his own peculiar contour, length of neck, or character of ribs; and, as glassware did not bear the maker's mark as did the earthenware of the same period, the age of the bottles is discovered by these characteristics alone.

A RAILROAD BOTTLE OF 1825.



BOOK BOTTLES. LARGE ONE HOLDS THREE QUARTS; SMALL ONE, ONE PINT.

A CURIOUS COLLECTION OF BOTTLES.

The oldest bottles are distinguished by the shape of the mouth, which is straight and plain, and was cut off with shears irregularly at the top while still plastic; and also by the rough circular scar on the bottom, left when the bottle was broken off from the punty rod by the workman. Bottles of a later date have a rim around the mouth and a smooth, hollow base, due to the improvement in manufacture whereby a case was used to hold the glass. Later still, bottles and flasks were made with plain, flat bottoms.

Not only are these bottles interesting in form and color, but the decorations upon them are of peculiar historical value to Americans, as they bear portraits of many of our national heroes, and many of the incidents of our early history are recorded upon their sides.

The story of our glass manufacture goes back to the time of our colonies, when glass bottles and beads were made for trade with the Indians. But the chief interest to a bottle collector lies in the output of the first half of the nineteenth century. During those years the potters of Staffordshire were decorating blue dinner sets with portraits of our political and military heroes, and sending them in great quantities to our shores. The exceeding popularity of these historical dishes prompted the makers of bottles to adopt the same practice; and straightway the faces of Washington, Franklin, Lafayette, and other national characters were blown in the sides of flasks. Many of the portraits are easily recognizable, and reflect credit upon the artists who made the design.

The American eagle and shield, various Masonic emblems, a cornucopia filled with fruit, and vases of flowers were also used. I have seen a curious old American bottle in the form of a violin, with the glass colored the soft yellows and browns of that instrument.

One of the oldest and most historic is the railroad bottle, made in 1825. Our first railroad was a primitive affair of wooden rail and horse power, yet its memory survives in these quaint glass souvenirs. The one pictured in the illustration is of a rich brown color, and has in relief on one side a horse drawing a loaded car along a wooden rail. Above are the words "Success to the Railroad." On the reverse is the American eagle and stars, all in relief. The story of the "Success" thus naively predicted, and since made real in our twentieth century rolling palaces of speed and luxury, would be an Arabian night's entertainment to the originator of this quaint design. Another railroad bottle has the word "Railroad" in relief above the horse and wagon, while below is the word "Lowell."

The bottle bearing the head of Gen. Lafayette on one side and of De Witt Clinton on the other commemorates the opening of the Erie Canal in 1825, at which ceremony the French general was present.

The famous "Log Cabin" and "Hard Cider" campaign of 1840 is responsible for bottles in the form of a log cabin. These have a door and windows indicated upon them, and upon the sloping roof the date "1840" appears. The chimney serves for the mouth of the bottle.

Our war with Mexico in 1846-47 gave occasion for special designs in bottles. The head of Zachary Taylor, with the words "General Taylor never surrenders" appears upon some; while others bear the bust of Capt. Braxton Bragg, with Gen. Taylor's famous command to him, "A little more grape, Capt. Bragg," in raised letters above the head.

The rush for gold to California, beginning in 1849, gave rise to bottles with exceedingly realistic decoration. The long-faced gentleman in the illustration in military cap and claw-hammer coat, with his bundle of mining tools slung over his shoulder, is evidently making rapid strides into the West. His attire no doubt is meant to signify the haste in which he left his home. Old residents of western New York remember seeing "prairie schooners" passing westward along the road from Buffalo to Chicago, with "Pike's Peak or bust!" painted on the canvas covers. Returning stragglers displayed only the last word of this motto.

The Jenny Lind and Kossuth bottles commemorate the visits of those famous celebrities to our shores, while the bottle bearing the face of Charley Ross recalls one of the saddest incidents of its kind in our history.

The collector in his search for bottles will find curious specimens made in the shape of books. These are of various sizes. The larger one in the illustration will hold three quarts, and the smaller one pint. The mouth is situated near the back of the book. These bottles are not made of glass, but of the rich brown pottery of Bennington, Vt. Old people tell me that these book-bottles were designed in this form so that liquid refreshment of various sorts—buttermilk, cold tea, or possibly something stronger—might be conveniently carried to church services, which, in olden times, were affairs of the whole Sabbath day. The morning service was followed by intermission for rest and luncheon before the service of the afternoon. Another story is to the effect that these book-bottles were made to evade the prohibition laws of New England. The words "Departed Spirits" which are imprinted in the back of one of the smaller bottles leave the reader in puzzled uncertainty as to whether they were meant to apply to the inner condition of the bottle or to direct the thoughts to realms above.

About eighty different designs of old glass bottles have been found. They are not to be despised as plebeian. They deserve a place beside the cherished china and pewter of their own generation, and should be carefully preserved.

* From American Homes and Gardens. Published by Munn & Co.

E. L. Nichols has examined the intensity in different parts of the spectrum of the light received from the sky on overcast or partially overcast days. The experiments were made, mostly in the Alps, with a spectrophotometer of the Lummer-Brodhun type, so arranged that one collimator pointed to the zenith while the other received the light from a comparison source of nearly constant intensity and composition. An acetylene flame was used for the purpose. Measurements were made throughout the visible spectrum from the extreme red at 0.74 μ to the extreme violet at 0.38 μ. The results are shown by curves in which the scale is entirely arbitrary, and thus they have only comparative value. On completely overcast days the curves were very simple, and similar to those obtained on some days of cloudless sky. They show a steady falling off from violet to red, with a slight droop in the extreme violet. On days of intense blue sky this droop in the violet is entirely absent, and there is also a relative increase in the brilliancy of the red end of the spectrum. The curves for misty days show a very characteristic maximum in the blue at 0.42 μ. This maximum in the blue appears regularly as the day advances in the mountainous regions of Switzerland during fine summer weather, when there is a gradual formation of mist in the upper atmosphere, gathering into cloud masses with a tendency to thunder showers in the afternoon. Mr. Nichols gives some interesting diagrams showing the diurnal variation from the simple curve for a cloudless sky in the early morning to the typical midday curve with the maximum at 0.42 μ and back to the simple curve in the evening.

THE FIXATION OF ATMOSPHERIC NITROGEN.

BIRKELAND-EYDE PROCESS.

BY SAM EYDE.

MORE than a hundred years ago, Priestley and Cavendish observed that the oxidation of atmospheric nitrogen took place on heating in an electric flame, and men like Sir William Crookes and Lord Rayleigh have, with others in recent years, given valuable contributions to the subject. With respect to later experiments before those of Birkeland and Eyde, which are of a more practical nature, the work which Lovejoy and Bradley have done should be mentioned as very important. Time will not admit of entering into the details of the various systems. In shortly describing the difference between previous methods and that of Birkeland-Eyde, it must suffice to say that the latter have applied large quantities of electric energy in the electric arc, and have found out the best method of doing this, while it was previously believed that it was small quantities of energy that gave relatively the best results. It is on that assumption that the apparatus employed by them was constructed. Thus the invention of Birkeland-Eyde completely revolutionized the theory of the process of atmospheric combustion.

By bringing great quantities of energy into the electric arc, and finding the most suitable electric conditions and most serviceable types of furnace, Birkeland-Eyde created the synthetical nitrate industry.

I venture here to express my belief that, however many systems may be discovered in the future, and whatever improvements any of these systems may effect, with regard either to the product or the method of production, they will all, in a greater or lesser degree, employ large quantities of energy in the electric arc.

ACID-PROOF RECEPTACLES INTO WHICH VAPORS PASS.

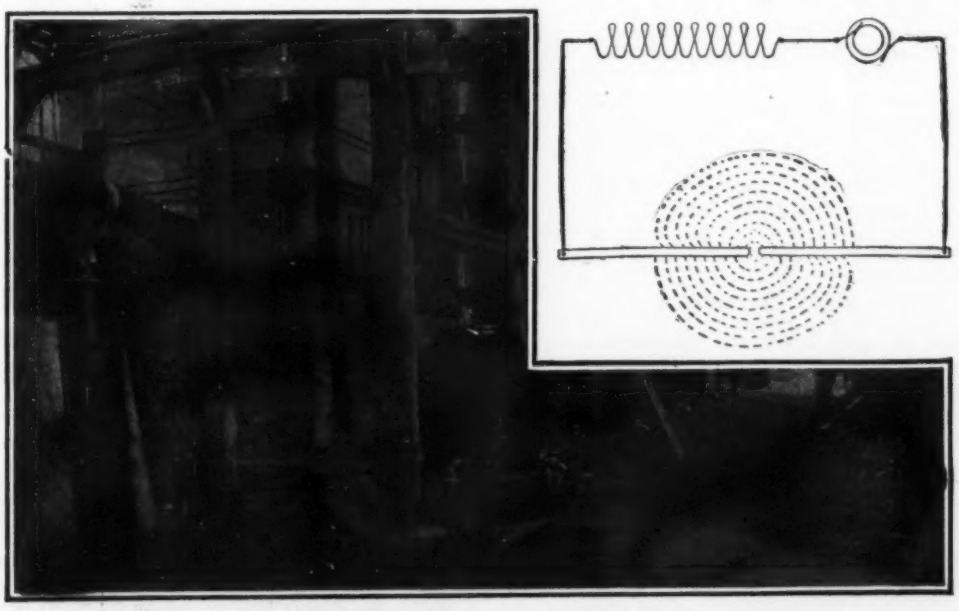
In order to explain the Birkeland-Eyde method, it is necessary first to describe the flames, consisting of arcs of light, which are used in the electric furnaces.

The formation of the flame occurs through an arc of the electric flame being formed between the points of the electrodes, which are close to each other. By this an easily movable and flexible current is established, which, with the arrangements made, will be found in a highly magnetized field. The electric arc that has been formed, moves on account of this magnetic field with great velocity perpendicularly to the lines of force, and the electric arc's foot draws back from the points of the electrodes. When the length of the electric arc increases, the electric resistance becomes greater and the tension increases, until it becomes so great that a new electric arc starts from the points of the electrodes.

To regulate the current, an inductive resistance is used in series with the flame. With alternating current, all these arcs are formed in opposite directions and appear to the eye to be circular disks. It appears that we have discovered in this flame a powerful technical means for the oxidation of the nitrogen of the air. The flame in our furnaces burns with a steadiness that is really astonishing.

THE ARCS ARE FORMED IN FLAT IRON DRUMS.

THE OXIDIZING CHAMBERS.



ABSORPTION SYSTEM OF STONE TOWERS FOR PRODUCING NITRIC ACID.

On electrodes of 1.5-centimeter thick copper tubing, through which water passes for cooling them, one can take up over 1,500 horse-power, with a flame 1.8 meters in diameter. The chamber in which the flame burns is circular, of only a few centimeters width, and about 2 meters diameter. After the oxide of nitrogen is formed in the furnace, it is converted in the oxidation tank into dioxide of nitrogen, and in the absorption towers into nitric acid.

From furnaces no larger than could be held in the hand, and which took an energy of some few horse-powers, we have attained to types which can, as mentioned, take an energy of more than 1,500 horse-power, and from absorption apparatus of glass globes of a few liters capacity to absorption towers of granite with a capacity of 600 cubic meters each. We have in the course of this period of developing our method had four experimental stations. The first attempts were made at Frognerkilens factory in 1903. As we could not obtain more than 20 kilowatts of electric energy there, the experimental station was removed in October, 1903, to a building of our own on Ankerlökken, with power from the Christiania municipal electric power station, and, to obtain still more power, to Vasmoen, near Arendal, and later to Notodden.

THE FURNACE HOUSE.

The building in which the furnaces are placed has a floor surface of about 2,000 square meters. It is entirely constructed of masonry and iron. In the basement are tubes for admitting the air and others for carrying off the gas. The power from our station at Svælgfos is brought in by 18 copper wires, each 12

millimeters in thickness. When these have been brought into the furnace house, they pass through oil-cooled current converters. In order to be able to supply each furnace with the amount of power desired, each is furnished with an induction coil, by means of which the power is regulated as required. The induction coil serves, moreover, to make the flame in the furnace steady and even while working. Of the 36 furnaces installed, 32 receive their power from Svælgfos and 4 from Tinfos power station.

The flame chamber of the furnace is formed of fireclay brick, through the walls of which the air is conveyed to the flame. The nitrous gases formed in the flame escape through a channel made along the casing of the furnace, which, like the flame chamber, is furnished with fireproof lining.

With this furnace we have achieved such steady working, that it burns for weeks without any regulation worth mentioning. It may further be stated, that the maintenance of the furnace and its repair are simple to a degree, as the most exposed portions, the electrodes, only require to be changed every third or fourth week, and the fireproof masonry every fourth to sixth month.

The temperature in our flames exceeds 3,000 or perhaps 3,500 deg. C. The temperature of the escaping gases may vary between 800 and 1,000 deg. during ordinary working. The furnaces are made of cast steel and iron, the middle of the furnace being built out to a circular flame chamber. The electrodes are led radially into this flame chamber. By aid of centrifugal fans, the air is brought into each furnace through tubes from the basement.

When the air in the flame chamber has been treated by the electric flames, the nitrous gases formed pass out through a channel built along the casing of the furnace and thence out through the lower part of the furnace to two fireproof-lined gas-collecting pipes, about 2 meters in diameter, which convey the gas through the basement out to the steam boiler house. In the boiler house, the gas passes through four steam boilers, in which the temperature, which was, as mentioned, 1,000 deg. C., is reduced. The heat given off by the gas is used for concentrating the products, and in the winter time for warming the factory buildings.

The steam produced in the boilers is utilized in the further treatment of the products. In the boiler house there are also two large and two small air compressors, which supply compressed air for pumping acids and lye in the factory's various chemical departments.

The gases pass on from the steam boilers through an iron pipe into the cooling house, with the object of completing the cooling commenced in the steam boilers. This cooling is necessary in order to obtain a suitable absorption. Each cooler consists of a great number of aluminium tubes, over which cold water runs, while the hot gases pass through them. The temperature of the gas is considerably reduced. From the cooling chambers the gases go on to the oxidation tanks.

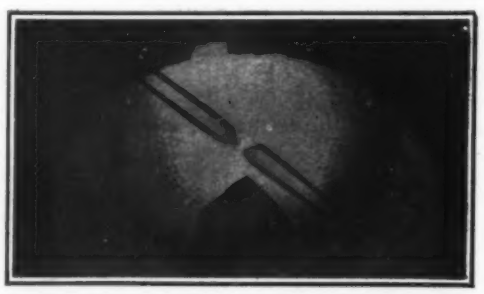
These oxidation tanks are vertical iron cylinders, lined with acid-proof stone. The object is to give the cooled gases a sufficient period of repose, in which the oxidation of the oxide of nitrogen may have time to take place. The necessary amount of oxygen is present in ample quantity in the air which accompanies the gases from the furnaces. From the oxidation tanks the gases are led into the absorption towers. All the towers are filled with broken quartz, which is neither affected by nitrous gases, nor by nitric acid. To assist the passage of the gases on their way from the furnaces, there are centrifugal fans, constructed of aluminium, on each row of towers.

The gases enter at the base of the first tower, go up through the quartz packing and thence by a large earthenware pipe enter the top of another tower through which they pass downward through the quartz to the bottom of the third tower, and so on, until the air, relieved of all nitrous gases, leaves the last tower. Water trickles through the granite towers and this is gradually converted into a weak nitric acid, while the liquid used in the wooden towers is a solution of soda. The absorbing liquid enters the top of the tower and is distributed in jets by a series of earthenware pipes, so that the permeating gases come in immediate contact with the absorbing liquid. In the granite towers nitric acid is thus formed, and in the wooden towers a solution of nitrate of soda.

The liquid emerges in a constant, even stream from the bottom of the towers, that from the granite towers running into a granite cistern. Hence it flows into the "montejus" which serve to pump up the acid, which has to pass repeatedly through the tower before it has become strong enough for the purpose for which it is intended. The "montejus" are of stoneware strengthened with iron shields, are worked by compressed air, and send the acid up into large stoneware jars. From these jars the acid again runs through the towers as described. The "montejus" work automatically. The wooden towers are percolated, as already mentioned, by a solution of soda, otherwise the whole process is practically similar to that in the granite towers. The solution of soda, owing to its far greater power of absorption, effects the separation of the last remains of nitrogenous gases from the accompanying air. Of the entire quantity of nitrous gases passed through the absorption system, about 97 per cent is absorbed. The finished nitric acid coming from the towers, which has a strength of about 30 per cent by volume, is collected in granite cisterns, from which it is drawn to what is called the "dissolution works." These consist of granite vats filled with limestone, over which the acid is poured. This drives off, with violent effervescence, the carbonic acid contained in the limestone, while the nitric acid takes its place and forms a watery solution of nitrate of lime or calcium nitrate. This solution of nitrate of lime is now pumped into vacuum evaporating apparatus. The object of boiling in vacuum is the well-known fact that great saving is thereby effected in the heat required.

The steam required for the evaporization is obtained from the steam boilers, heated, as before mentioned, by furnace gases. The concentration of the nitrate solution in the evaporizing plant is continued until the specific weight of the liquid at a given temperature shows a content of 13 per cent of nitrogen. This solution is then sufficiently evaporated, and can be pumped up into the solidification chambers. These are fitted with shallow iron pans, under which cold air is pumped to accelerate cooling. After some time the nitrate stiffens into a brittle, crystalline mass, hard as stone. This is broken up into lumps, and is taken into the crushing machines. These consist of ball crushing mills, which reduce the mass to a granular state. The coarse powder so produced is raised by elevator to a vat, from the bottom of which it is tapped into casks holding 100 kilos net weight.

The barrels are made at our own cooper shop and are lined with paper to guard against damp. The color of the product depends on the limestone used in the manufacture. The nitrate of lime is used in various chemical works as well as for manure, the only difference being that, for the former purpose, the product is not ground fine, but is run direct in



THE ELECTRIC ARC FLAME AND WATER-COOLED ELECTRODES.

the liquid state into thin iron drums, in which it stiffens into a solid mass.

THE MANUFACTURE OF NITRITE—NITRITE OF SODA.

It now remains only to mention the further treatment of the nitrite formed in the alkaline towers. When this is pumped away from the towers, it contains, besides nitrite and water, also some nitrate of soda, and bicarbonate.

The further process is designed to separate the pure nitrite from the other substances. This is accomplished by first boiling away some of the water, which is done, as in the case of the nitrate solution, by steam from the steam boilers, heated by the furnace gases. The nitrite solution, concentrated to a suitable boiling state, is run into crystallization pans, in which the crystallization of the nitrite takes place. The crystals are separated by centrifugal means and are conveyed by a screw transporter to a drying apparatus, where they are subjected to a current of hot air. The finished product is then run into casks containing 300 kilos each. These are likewise made in our own shops. This nitrite of soda is used as the raw material in the manufacture of certain kinds of aniline colors. The manufacture of nitrite is carried on in a special building.

In the entire process of manufacture, both of nitrite and nitrate, no coal is used; all the machinery is worked by electric power, and for heating and evaporating the nitrate and nitrite solutions, the only steam employed is that obtained by the hot gases passing through a system of steam boilers.

We are, moreover, in our industry, not confined to the two products hitherto mentioned, nitrate of lime and nitrite of soda; we have possibilities for the development of a whole series of new industries, of which I will specially name the production of nitric acid, nitrate of ammonia, nitrate of potassium, and others.

We have succeeded, in conjunction with the Nobel (nitro-glycerine, etc.) Syndicate, in concentrating our weak acids, by means of gases from our furnaces, to acids of a high percentage which can be transported.

AGRICULTURE—TRIALS WITH NITRATE OF LIME.

In recent years a number of well-known men and institutes connected with agriculture have undertaken numerous experiments for the purpose of testing the effect of the nitrate of lime under various climatic and other conditions and on various kinds of soil. These trials have been made in Norway, Sweden, France, Germany, Austria-Hungary, Italy, and also in the United Kingdom.

All the experiments have fully confirmed the expectation which was held forth by men of science when this new manure first appeared, viz., that one pound of nitrogen in the form of nitrate of lime has the same effect, both in quality and quantity, as a similar amount of nitrogen in the shape of nitrate of soda, or, in other words, that nitrate of lime is equal to nitrate of soda as a manure.

At times variations may be observed one way or another, in one case in favor of the nitrate of soda, in another in favor of nitrate of lime. But especially in soils deficient in lime, the nitrate of lime has proved superior.

A number of agricultural chemists have conducted pot-experiments to compare nitrate of lime with nitrate of soda. I may name among others: Prof. Sebelin, the College of Agriculture, Aas, Norway; Dr. E. Solberg, head of the Agriculture Experiment Station, Trondjhem, Norway; Prof. Söderbaam, Sweden; Prof. Paul Wagner, Darmstadt, Germany; Prof. Th. Schloesing, Jr., Paris; and Mr. James Hendrick, chemist of the Highland Society of Scotland.

They all affirm that the nitrate of lime has proved to be fully equal to nitrate of soda as a manure, as long as the same quantities of nitrogen are employed. Prof. Wagner adds that the nitrate of lime is preferable on soils that are deficient in lime.

The field experiments are of still more practical importance, and a number of such have been made in various places in different countries. Especially extensive and exact field experiments have been made in the Scandinavian countries.

Norway.—Prof. Bastian R. Larsen, conductor of experiments at the Norwegian College of Agriculture, has, from 1904 to 1908, carried out a series of the most careful experiments to compare nitrate of soda with nitrate of lime.

Several parallel trials have been made each year, some on the college grounds, some on land in various parts of the country.

Putting the results for ordinary manuring with nitrate of soda at 100, the results for similar manuring with nitrate of lime have been:

Potato crop, 1904	146.3
Potato crop, 1905	100.9
Potato crop, 1906	97.1
Potato crop, 1907	109.3
Potato crop, 1908	100.0
Green fodder on marsh land, 1906	106.1
Top dressing on meadow, 1908	100.3

The professor concludes with the words: "The experiments referred to appear, on the whole, to demonstrate that the nitrogen in nitrate of lime is equally valuable as the nitrogen in nitrate of soda."

Denmark.—In Denmark a series of experiments has likewise been carried on for the purpose of comparing nitrate of soda with nitrate of lime. The Sealand Farming Associations have carried out 37 different trials on a number of farms. Putting the results for ordinary manuring with nitrate of soda at 100, the results with nitrate of lime are:

Experiments with—

	Grain.	Straw.
Rye (1907)	105.5	101.0
Oats (1907)	103.3	100.5
Barley (1907)	99.9	98.4
Barley (1908)	99.7	104.1
		Roots.
Beetroot (1907)	....	97.0
Beetroot (1908)	....	98.8
Sugar-beets (1907)	....	101.1
Sugar-beets (1908)	....	96.6

Nitrate of lime has thus in some instances been a little below nitrate of soda, in others a little above.

Sweden.—The Director, Herr P. Bolin, gives the following account of local farm trials (practical cultivation trials) made by the Hushallnings Association in Sweden.

Putting (as before) the effect with nitrate of soda at 100, the results with nitrate of lime were:

	Grain.	Straw.
Experiments with oats in 1904	104.5	118.0
Experiments with oats in 1905	137.5	100.0
Experiments with oats in 1906	105.0	93.4
Experiments with hay in 1906	100.9	

In these experiments nitrate of lime proved considerably superior to nitrate of soda.

The director states respecting a number of experiments with roots in 1906: "Apart from some irregular instances the experiments made with roots appear to confirm the observations which have previously been made by ourselves and others."

The United Kingdom.—The average results of three

trials of nitrate of lime with oats made by Mr. James Hendrick, chemist of the Highland and Agricultural Society of Scotland, have been:

	Yield per Acre		
	Grain.	Straw	
	Lbs.	Cwt. Qr.	Lbs.
1. No manure	2,348	33 0	21
2. Phosphate and potash only	2,532	37 1	6
3. Same as 2 with nitrate of soda	2,774	41 3	1
4. Same as 2 with sulphate of ammonia	2,774	41 3	24
5. Same as 2 with nitrate of lime	3,121	43 1	13

In these experiments nitrate of lime proved considerably superior to nitrate of soda.

Experiments with oats at the West of Scotland Agricultural College by Prof. R. Patrick Wright.

AVERAGE OF TWO TRIALS.

	Yield per Acre.				Ratio.	
	Grain	Straw.			Grain.	Straw.
	Lbs.	T.	Cwt.	Qr.		
Experiment of 1907:						
Nitrate of soda	1890	1	12	3	100	100
Nitrate of lime	2 40	1	10	1	108	93
Experiment of 1908:						
Nitrate of soda	2777	2	1	3	100	100
Nitrate of lime	3121	2	3	1	117	107

In both instances here quoted, nitrate of lime has thus shown itself to be superior to the nitrate of soda as a manure for oats, when the same quantity of nitrogen is employed, especially when the chief object is the weight of grain.

Experiments on roots at University College, Reading, by Prof. John Percival:

	Yield.
1. Nitrate of lime, 1½ cwt. per acre	37 tons
2. Nitrate of soda, 1½ cwt. per acre	36 tons
3 Sulphate of ammonia, 1½ cwt. per acre	32.5 tons
4. No manure	27.75 tons

It should here be observed that the largest crops have been obtained with the use of nitrate of lime, even when the same gross quantities have been employed, notwithstanding that the nitrate of lime only contains 13 per cent of nitrogen against 15 per cent in nitrate of soda and 20 per cent in sulphate of ammonia.

Experiments Made by Prof. B. W. Bull, of the Essex Education Committee.

Mangold Experiments, 1908.

	Tons.	Cwt.
1. Dung, superphosphate and nitrate of lime	29	12.8
2. Dung, superphosphate and nitrate of soda	28	3.6
3. Dung, superphosphate and sulphate of ammonia	26	7

A Trial of Slag, as a Spring Application.

	Tons.	Cwt.
1. Dung, superphosphate and nitrate of lime	22	15.7
2. Dung, superphosphate and nitrate of soda	21	18.7
3. Dung, superphosphate and sulphate of ammonia	19	2.1

SVÆLGFOS POWER STATION.

Svælgfos power station is about four and a half kilometers, barely three English miles, from Notodden factories, on the Tinn River, which, by the regulation of the lakes Tinnsjoen and Mosvand, has been brought up to a constant supply of seventy-five cubic meters of water per second.

The power station consists, in its main features, of a weir or dam, by which the water level has been raised 17 meters (about 56 feet).

A tunnel leads the water to the basin, whence it passes through four channels through the rock and lined with iron to the four turbines.

The effective height of the fall is 46½ meters—nearly 153 English feet.

There are four turbines installed, each of from 10,000 to 11,750 horse-power, thus, under normal circumstances, yielding 40,000 to 45,000 turbine horse-power.

The turbines are fitted with two wheels, to which the generators are coupled. The number of revolutions is 250 per minute. They are constructed by the firm of Voith in Heidenheim.

The generators were built by the Allmänna Svenska Electriska Aktiebolag, Vesteras, are three-phased current machines, with fifty periods per second, six hundred amperes per phase, and a tension of ten thousand volts, delivered directly upon the line.

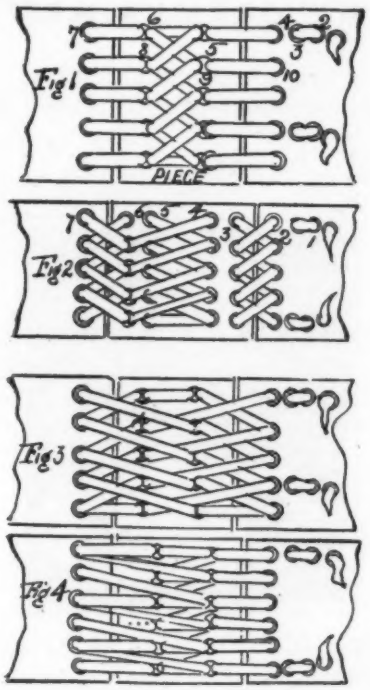
The power is conveyed to Notodden by three transmitting cables, each of six wires, and a fourth cable will shortly be added in order to utilize the power more completely.

The power station is erected in the bed of the river itself close in under the almost perpendicular western bank, and all the materials had to be lifted by cranes, fifty meters up or down. The heavy portions of the machinery were carried over to the power station by the aid of a very powerful aerial ropeway, stretched from the road on the east side of the river to the edge of the precipice.

This power station is of considerable interest, not only as being the largest water-power station in Europe, but on account of the plant there installed being doubtless the largest in the world at the present moment.

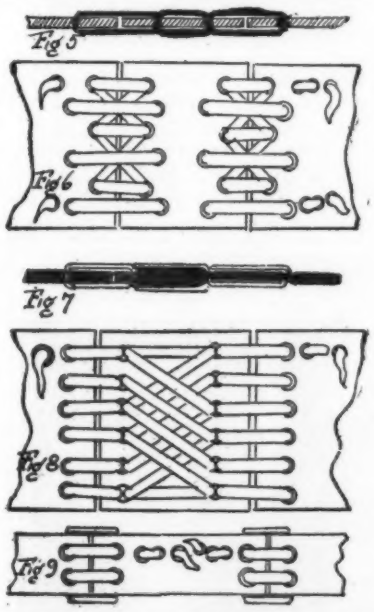
PUTTING A PIECE IN A BELT.

ONE of the most annoying things which may happen to machinery is to have the belt run short, necessitating either the substitution of a longer belt or the addition of a piece. The belt's shortness may be due to two or three causes. Perhaps some poor unions have been made at the joints and these have broken under



the running strain, causing the ends of the belt to tear and become disordered. The ragged end may have been trimmed off, thus shortening the belt. After the belt has been trimmed several times, as it will not stretch enough to make up for this loss of leather surface, the joint must either be expanded by letting out the laces, or a very tight belt must be run.

Perhaps the piece is added. The belt cannot be run with the ends of the leather belting at the joint separated a few inches to make up for the surplus torn edges which have been cut off, because the lace leather does not work well on the pulleys, nor can the break in the belt run smoothly. A very tight belt can never be run to advantage. One does not want to remove the belt just because it is a few inches short and put on an expensive new one of more length, so one usually puts in a piece. The illustrations are given to explain the process.



Let us suppose that we have a belt of moderate speed and a fair amount of work to do. The union must be strong and even. We take the ragged edges of the worn belt ends in hand, and trim off the butts, using a square for the marking and a sharp knife for cutting; then we make our intersecting joining piece likewise square on the ends so that it will fit snugly and properly. Next we punch the holes, having first lined the hole points with a ruler. The piece is then inserted and the process of lacing may proceed according to any of the plans shown in the sketches. If we conclude to do the sewing on the plan exhibited in Fig. 1, we draw out our long lace leather and put the proper tapering points on the same to enable it to enter the holes readily. We can lace double or single, or adopt the single sewing system and double back. Supposing we interlock the lace as shown in No. 1. Then we drop to hole 2 and up through 3. This gives us the grip required for holding the end of the lace leather. Then we lace to hole 4 and across underneath to 5, thence over to 6 and out to 7, then back to 8 and over to 9 and 10, and so on the other edge of the union. Just one half of the body of the lacing will be completed by this plan. Then in order to finish the other half, we simply work back through the holes on the same plan. This gives a strong union with the intersecting pieces fitted firmly in position. In the event that an extra amount of lacing will be required for heavy service, the trip over and through the lace holes may be repeated.

Fig. 2 is another form of lacing in which the crosses of the belt are all on one side. This is more practical than the other method of union. In the first example there are crosses and straight laces on both sides and no distinction can be made.

It is far better to run the joints with the straight laces on the face of the pulley. Hence, if the laces are straight on one side and crossed on the others, as in Fig. 2, the belt can be adjusted more easily. In the formation of this union, the ends are prepared and the mode of lacing is similar except the dropping of the lace through, to make the crosses on the first sample, and the holes are punched. The lower side is changed so as to bring the crosses on the face of the sewing. We begin at hole No. 1, and go to hole No. 2, then pass to 3, and thence to 4. We then pass the lacing to 5 and 6, finishing that crossing at 7. We can run the lace back again by following the lay of the laces in the cut without further description.

There are also forms of inserting a piece of leather belting in a joint, by sewing with extended lace, as in Fig. 3. It will be observed that the laces take a long jump from hole to hole. Some men prefer to use this wider expanse of lace leather. I find that some like to make the lace leather go as far as possible, and they economize space by shortening the laps, but it is better to be liberal in the distribution of the lace leather in making these types of joints. Therefore the extended lays of laces can be recommended for general surface. For exceedingly high-speed belts, however, it would not be advisable to have so much lace leather exposed.

I would not run into entangled lacing as in Fig. 4. I have seen belt-driving systems put out of effective running order due to the superabundance of lacing leather which is piled on to the laps. A sample of this kind of reckless lacing is shown in the model mentioned.

A very plain, yet useful, method of inserting a section of a belt is shown in Figs. 5 and 6. It will not be necessary to go into the details of the insertion of the individual strands in these models, as the plan can be easily followed. There is a great deal of lacing employed, because the laces are crossed and then passed over by the longer loops. The finished union is thereby rendered rather bulky. It might be better to omit the crosses on the face.

In Fig. 7 is another combination which attracted the attention of the writer. One may find some rather unique forms of lacing by traveling through shops. Almost every man has a way of his own. In the making of this joint (Fig. 7), the plan does not differ materially from the first one, except that there are crosses made on the under side as well as on the upper side. This is done by redrawing the strands. A second trip has to be made. This method will result in an extremely strong joint, but it will not avail unless the leather in the belting is exceptionally powerful. The lace will pull out the edge of the leather wherever there is undue strain. Ordinarily this union is very satisfactory.

We have the round belts to lace as well as the flat ones, and our last example (Fig. 9) illustrates one of the round kind with a piece inserted.

Drive punches must be used to insert a hole in the thick leather. These drive punches can be bought at any tool dealer's. Then cut the holes and insert the piece, and lace as shown in the drawing.—The Operative Miller.

A series of tests described in the Proceedings of the American Society of Civil Engineers by Prof. A. N. Talbot and Mr. H. F. Moore was undertaken with the object of determining the variations of longitudinal and lateral stress throughout the longitudinal elements of built-up steel columns, the amount and distribution of stress in the lattice bars, and the relation between the component parts and the column as a whole. The results throw some light on the question of the unity of action in built-up columns under load. In the absence of twisting action it may be concluded that the integrity of the cross-section exists with reference to a plane parallel to the bracing, but the same unity of

action is not so certain with reference to a plane perpendicular to the plane of the bracing. Moreover, the tests on the distribution of compressive stress and the cross-bending tests indicated that the built-up columns under examination generally acted as two members not fully restrained by the bracing. The effect of accidental eccentricity due to variations of workmanship and other irregularities was shown to be of considerable importance, and, as the paper demonstrates, a slight variation from straightness in the main longitudinals of a built-up column may account for a large increase of stress. This circumstance was emphasized several years ago in the able paper contributed by Mr. J. Mitchel Moncrieff to the American Society of Civil Engineers.

WHAT A VERY SMALL TELESCOPE WILL DO.*

SUGGESTIONS FOR THE AMATEUR ASTRONOMER.

BY ARTHUR MEE.

WE live in the day of great telescopes, yet the number who are privileged to use them is necessarily very limited, while the beginner is too often discouraged by the false idea that, after all, the heavens only reveal their beauty to the users of great instruments. As this undoubtedly deters numbers from taking up observational astronomy, I have put together these notes with a view of showing that very small telescopes, if good, are capable of revealing many interesting features and even of doing useful work.

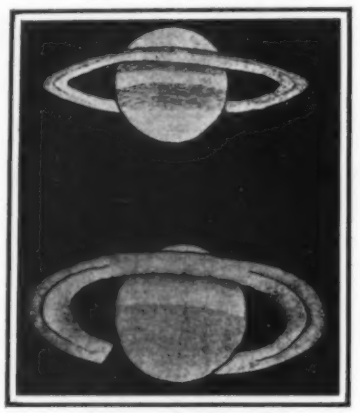
A 3-inch telescope is generally considered the smallest size that is of any use in astronomy, but there is ample evidence that even a 2-inch will do a great deal, provided it be of good quality and furnished with a really steady stand. Probably the stand is the weak point with many small telescopes. Large ones are usually mounted in a steady manner, and if a 2-inch is to do its utmost it must be at least as fairly treated in this respect as its big brother.

Let us glance rapidly at a few celestial objects and see what a very small telescope will show. I will pass over the great field of stars and nebulæ with only a word, because in these regions aperture is almost a necessity. Still, even here, a small instrument will do something if intelligently used. We have the authority of Webb that Castor has been seen double with aperture reduced to three-quarters of an inch; while Mr. Gore has seen four stars in the Trapezium with 1½-inch. Gamma Leonis has been split with the same aperture. Dr. Kitchener saw Rigel double with 1⅜-inch—an undoubtedly noteworthy achievement. Probably the beginner would be hardly so successful with very small aperture, and he would always have to keep his imagination in check. Still, these records show what a very small glass can do in good weather; while, of course, to merely sweep among the star fields will be a work of unending interest.

Coming now to the solar system, there are various objects which can be almost entirely ruled out. Among these are the planetoids, though some of them were discovered with small telescopes and the larger ones may be followed by such apertures as those under review. The Rev. S. J. Johnson—than whom few knew better how to employ a very small telescope to all-round advantage—saw Vesta emerge from occultation with a power of 70 on a 2¼-inch. The outer planets, Uranus and Neptune, can be easily followed with a 2-inch, and it is satisfactory to know that they are not wholly beyond our ken at the distance of 1,800 and 3,000 million miles respectively!

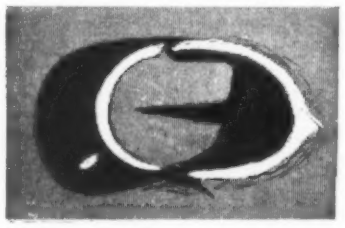
Mars is a deeply interesting object, but admittedly difficult for very small apertures. It takes a good telescope to bring out his delicate markings in perfection. Still, the larger features—the polar snow and the main outlines of the "continents"—are not entirely beyond our reach. A spot has been seen on Mars with only 1½-inch, and Johnson tells us how astonished he was after viewing the planet with a 4-inch achromatic to see how pluckily a smaller instrument dealt with it. "Everything that could be seen with 4-inch could be distinctly traced with 2¼-inch, only smaller and a little fainter."

But the most remarkable testimony to what a first-rate 2-inch achromatic will reveal on Mars is afforded by Mr. Charles Grover, of Rousdon. Some years ago that veteran astronomer placed in my hands his old observing book, containing drawings of the planets made in the sixties with the above small aperture. The Mars designs exhibit the main features of the planet in a masterly manner, and there are larger telescopes which would reveal no more detail than Mr. Grover's keen eye was enabled to catch. Of course, Mars must be favorably situated for such work to be done with such very feeble optical means, but no doubt it will surprise many readers that it can be done at all!



SATURN—1865, MAY, AND 1866, JANUARY.

(Drawn with 2-inch achromatic. Exactly reproduced from Mr. Grover's observation book.)

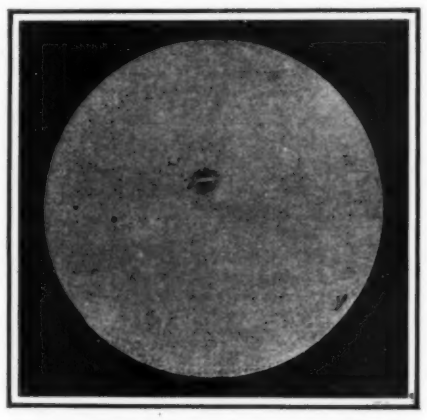


LUNAR WALLED-PLAIN—PLATO—FEBRUARY 17th, 1866.

(Drawn by Mr. Grover with 2-inch achromatic.)

Compared with the objects we have been considering, Jupiter is very easy. He has an expansive disk which a power of only 40 renders as large as the naked eye moon, while his four largest satellites are strikingly apparent in a 2-inch, and one or two of them are said to have been even glimpsed without any instrument. As Mr. T. K. Jenkins, a Welsh workingman astronomer, has lately shown, a 2-inch is capable of giving clear views of the belts and of the shadow-transits of the satellites. The colors of the belts have just been caught with 2¼-inch.

Despite his much greater distance, Saturn is fully as interesting in our little telescope as Jupiter. Turning my 8½-inch Calver, power 60, and a 2-inch Burnerd, power 80, on the planet, I was surprised to find how well the little achromatic stood the test. Of course, with a higher power the Calver would leave the other hopelessly behind. Still, it was evident that the main features were quite within reach of the 2-inch. Many observers could be quoted to show what such an aperture can do with Saturn, but I will merely instance Grover, who saw the belt on the ball, Cassini's division in the ansæ, the dusky tint of the outer ring, the shadow of the ball on the ring, and other features. Of the satellites, Titan and possibly Japetus are within the scope of the 2-inch, but Proctor's statement that they might at times be caught by an opera glass should certainly not be taken too literally.

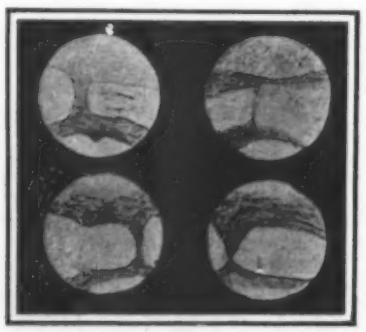


THE SUN—JULY 16th, 1905.

(Drawn with a small hand telescope, power 12 and dark cap. Arthur Mee.)

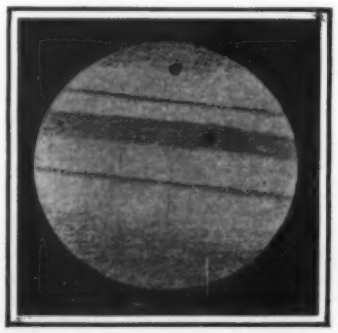
To the possessor of a good 2-inch the moon will be found an object of perennial interest. As Mr. Holmes says, all except the minuter features are plainly visible, and unless the observer be a very capable artist he will find that he will see more than he can satisfactorily depict. In this connection it is interesting to note that Prof. Phillips, after studying the moon with the great Rosse telescope, passed to a Cooke refractor of about 2¼-inch aperture—a remarkable transit indeed! Johnson says that with such a telescope he found a power of 200 "very serviceable" on the moon, but the beginner will probably be satisfied with much lower magnification. Johnson, however, loved deep eyepieces, and was not afraid of 420 on a 4-inch achromatic.

On the sun the owner of a good 2-inch will find his instrument specially effective, spot details, faculæ, and the mottling all being beautifully visible with a dark cap. With good air I know nothing more exquisite



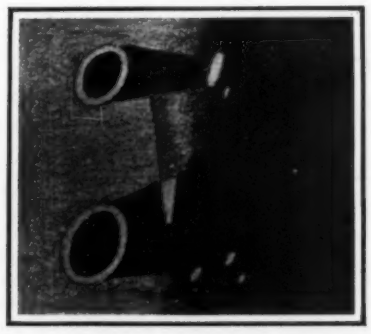
MARS—1866-7.

(Drawn with 2-inch achromatic. Exactly reproduced from Mr. Grover's observation book.)



JUPITER AND SATELLITE SHADOWS IN TRANSIT—OCTOBER 12th, 1904.

(Drawn with 2-inch Wray by T. K. Jenkins, Blaina.)



LUNAR CRATERS—DIOPHANTUS AND DELISLE.

(Drawn with 2-inch Wray by T. K. Jenkins.)

* Knowledge and Scientific News.

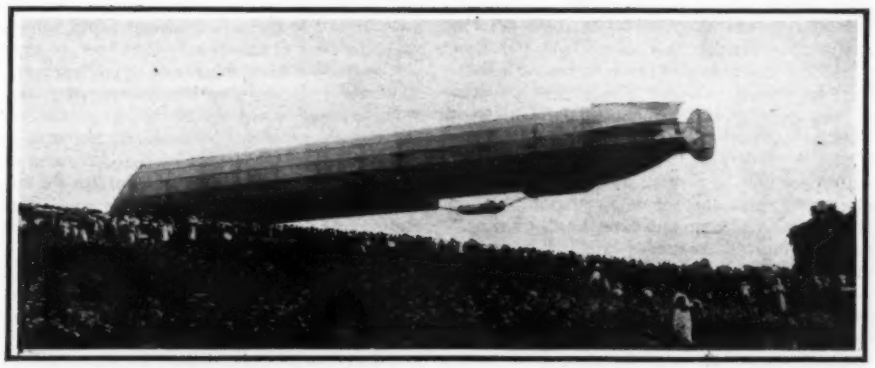
than the solar surface as viewed with such a telescope, and the observer will find useful work awaiting him if he studies the sun from day to day and makes careful notes and drawings.

Much more might be said on this subject. The general absence of atmospheric tremor in a small achromatic, and the consequent hardness of the images, are points not to be forgotten; while the extreme portability of the instrument is another argument in its favor. Certainly the possessor of a first-rate 2-inch will be loth to part with it when he discovers for himself the extent of its usefulness.

THE RECORD FLIGHT OF "ZEPPELIN II."

FURTHER DETAILS OF THIS NEW AIRSHIP'S RECORD JOURNEY AND A FULL ACCOUNT OF ITS ACCIDENT.

READERS of the SCIENTIFIC AMERICAN are familiar with the brilliant achievement of the new airship "Zeppelin II," by which all records were broken in a phenomenal flight of 700 miles accomplished in 37½ hours.

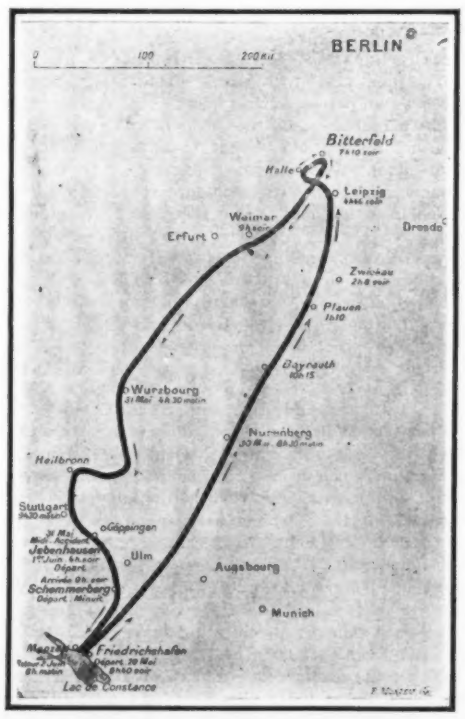


THE GERMAN GOVERNMENT AIRSHIP "ZEPPELIN II" IMPALED UPON A TREE AT GOEPPINGEN.

Note the large vertical rudder at the rear. This was not fitted to the "Zeppelin I."

Unfortunately, this triumphant journey ended in an accident so grave that it seemed at first only less a catastrophe than that at Echterdingen in August, 1908, when the "Zeppelin IV" was utterly demolished. The opponents of the rigid system hastened to point out that the fragility of the aluminium frame rendered it peculiarly liable to such accidents, and declared that they had always predicted just such probable mishaps under the given conditions.

A serious controversy had already arisen between the Zeppelin Construction Company and the military



MAP SHOWING COURSE FOLLOWED BY THE "ZEPPELIN II" IN ITS RECORD FLIGHT.

authorities, the latter not only having announced that no more "Zeppelins" would be acquired at present, but going so far as to plan the construction of the balloon sheds at the new line of aerostatic stations in such manner that both shape and size made it impossible for the "Zeppelins" to enter therein.

But at the very moment when all seemed lost to the Zeppelin advocates, the skill, courage, and resourcefulness of the indomitable inventor enabled him once more to snatch victory from the very jaws of defeat.

It is not too much to say that the accident and the manner in which it was met form the crowning glory of the whole wonderful feat, and have resulted in a remarkable revulsion of opinion both in Germany and among more disinterested nations. The history of the race is the history of the child. We learn to walk through stumbling. Progress is achieved by means of vanquished errors.

The accident at Goeppingen is peculiarly instructive, both as regards its causes and the means taken to minimize its effects. We therefore present a full account of it.

The "Zeppelin II," as stated in our SUPPLEMENT No. 1745, differs in some few respects from the "Zeppelin I." It is 136 meters long by 13 meters in diameter, two of the propellers have been made two-bladed instead of three-bladed, and it carries a large vertical rudder at the stern. The propellers make 900 revolutions per minute. It is also provided with an improvement in the shape of a ladder passing through one of the central compartments to a small platform on top, and thus providing a means for reconnoitering.

After short trial trips on the 26th and 28th of May, the new "Zeppelin II" left its shed at Friedrichshafen on Lake Constance on May 29th at 9:50 P. M.

Its crew consisted of Count Zeppelin, Chief Engineer Dürr, Engineer Stahl, two aero captains, and three mechanics.

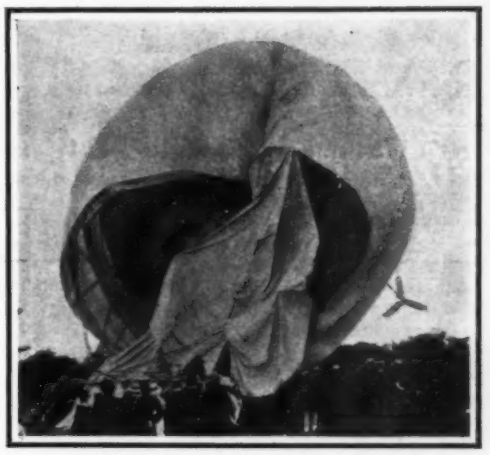
Its route as given in the accompanying map described an irregular ellipse with Bitterfeld at the farther end, a distance of 348 miles from the starting point. Nuremberg, Baireuth, and Leipzig were passed without adventure, and it was generally supposed by the vast crowds which gathered to watch the monster airship that its destination was Berlin.

A false dispatch, supposed at first to have been dropped by the Count, was sent to the capital to that effect. The Emperor was notified, and motored in from Potsdam with a large retinue, going at once to the Tempelhof field, where troops were already assembled to be in readiness to receive the successful aeronaut. Many thousands of the populace gathered likewise to applaud the popular hero of the day.

After several hours of weary, anxious, and finally apprehensive waiting, news was received that the airship had turned southward after reaching Bitterfeld, a distance of only 85 miles from Berlin.

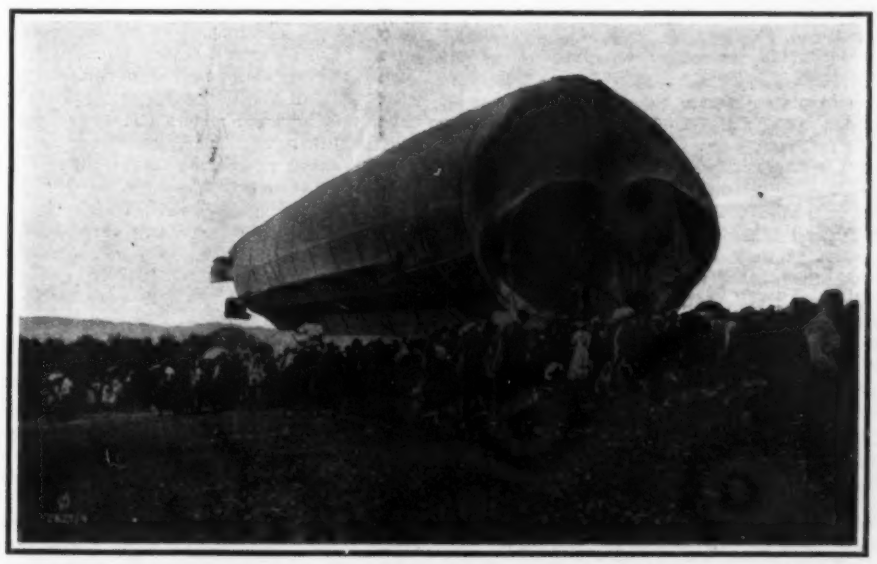
The Count, in ignorance of the hopes he was disappointing, had determined, because of a head wind and a diminishing supply of fuel, to retrace his course. The return trip was accomplished successfully past Weimar and Stuttgart, when the small remaining amount of gasoline induced a descent on an open plain near Goeppingen, at which place a petroleum refinery is situated.

It was raining heavily, which forbade reconnoitering, the motors were stopped, and at 11:20 A. M. on May 31st the huge airship began to descend. All seemed well until suddenly there appeared below, the gaunt bare limbs of a half-dead pear tree. Count Zeppelin, who was acting as pilot, gave a sharp order to starboard the helm. The man in charge—one of the aero captains—made a mistake and thrust the helm to port. At that instant a sudden gust sprang up and drove the helpless craft head on against the tree. The



DETAIL VIEW OF THE DAMAGED FRONT END, SHOWING BROKEN ALUMINIUM GIRDERS.

prow was wrecked for a distance of 30 meters—nearly a fourth of its length—the frame being badly smashed and the envelope torn. Had the motors been in operation, the force of the collision would have been, of course, much greater. On the other hand, since the



END VIEW OF THE AIRSHIP, SHOWING THE TREE WHICH CAUSED THE DAMAGE.

THE RECORD FLIGHT OF "ZEPPELIN II."

propellers are reversible, and the dynamic power very great, the crash might have been avoided if the obstacle had been seen in time. In this connection it is interesting to note Count Zeppelin's statement in a recent lecture that the momentum of the huge craft is so great as to drive it forward for half an hour after the stopping of the screws. The most significant feature of the affair, however, lies in the fact that the fatal error of the man at the helm was due to his having been overcome with fatigue from an over-long vigil. In order to carry a larger supply of fuel—about 2,500 kilogrammes (5,512 pounds) was consumed—the crew was reduced to eight men, a number insufficient for proper change of relays on so long a trip. It is obvious that in the future the airship operator must be guarded as carefully as the locomotive driver from over-weariness or nervous breakdown.

In the face of this overwhelming disaster, the Count remained cool, collected, courageous—master of himself and of the situation.

Three hours later preparations had already been made for a rapid repair. The prow of the ship had been sawed loose from the entangling branches; twenty workmen had been summoned by telegraph from Friedrichshafen, about sixty miles distant, and were on their way in automobiles; troops and police were on guard; wires had been run from a near-by electric light plant to furnish light for night repairs; and a near-by factory had arranged to furnish tools and machines.

A temporary prow was constructed, the ribs being formed of young firs, and covered with balloon cloth.

The motors and other impedimenta were taken from the forward car, the sliding weight was also removed, fresh supplies of gas and gasoline were taken on, and exactly 28 hours after the catastrophe, at 3:20 P. M., June 1st, it was announced that the craft was ready to resume its trip with a crew of five men, one of whom took the place of the sliding weight and performed its functions.

The vast assembled crowds watched breathless till the great ship, with Chief Engineer Dürr at the helm, had risen slowly but surely into the air like Sindbad's roc from the Valley of Diamonds. Then a mighty cheer burst forth, a tribute to the dauntless spirit of the white-haired man who stood before them, still cool, composed, and courageous, ready for emergencies, no more vainglorious in the hour of victory than he had been downcast in the hour of seeming defeat.

Very slowly and cautiously the flight was continued, Count Zeppelin following the crippled craft in an automobile. At 8 P. M. a descent was made at Schemmerberg, about 46½ miles having been covered in 4¾ hours, at a speed of nearly 10 miles an hour.

New supplies having been taken on, the airship rose again at 12:40 A. M. on June 2nd, reached Friedrichshafen at 5:50 A. M., thus covering 46½ miles in about 5 hours. At a few minutes past 6 o'clock it was safe within its shed.

Thus was accomplished one of the most marvelous achievements in the history of the world. All Germany went mad with joy. The Emperor telegraphed his congratulations, declaring that this feat established conclusively the merits of the rigid system. The Count pointed out that just such a concatenation of unfavorable circumstances might have caused a similar accident on the sea, but that in such case a steamship with her bows stove in would be quite helpless and unmanageable.

Latest advices state, too, that the Minister of War has issued orders for the new sheds to be changed in plan, being made round instead of rectangular and of increased size, so as to accommodate the "Zeppelins."

In brief, the disaster has been productive of unlooked-for good in various directions.

In summing up this record voyage, attention should be called to the fact that the airship experienced unfavorable conditions during part of its journey. The start was at night, and the next morning, after a distance of about 200 miles had been traversed, the hot sun expanded the gas to such an extent that the airship had a strong tendency to rise. As a consequence, it was necessary to point it downward in order to keep it from ascending too high, and this of course cut down the speed considerably. During the next 150 miles a strong head wind was experienced; and as a consequence of these two opposing forces, an average speed of but 16.4 miles per hour was maintained to the turning point at Bitterfeld, 348 miles from Friedrichshafen. After making the turn the wind was favorable as far as Weimar, and during some of this part of the journey only one motor was used. The valley of the Neckar was followed for a considerable distance. The 109 miles from Weimar to Wurzburg was covered in 7½ hours, at an average speed of 14½ miles an hour, while the 96 miles from Wurzburg to Stuttgart was traversed in 5 hours, at an average speed of 19 1/5 miles an hour. This latter stretch seems to have been covered at the fastest speed obtained during any part of the journey. During the last 25 miles, from Stuttgart to Goeppingen, the airship traveled against a rather strong southwest wind. The total distance from Friedrichshafen to Goeppingen—603 miles—was covered in 37½ hours, at an average speed of 16.1 miles per hour. After the accident and the making of repairs, the huge craft averaged nearly 10 miles per hour for the 87 miles it had to traverse to complete its journey. Taking into consideration the slow average speed made before the accident, the vessel did remarkably well to make nearly 10 miles an hour afterward.

The average speed maintained in this 700-mile voyage was by no means so great as that maintained by the "Zeppelin IV" last August, as the latter made 29 miles an hour for a good part of its journey. This seems to have been due to unfavorable weather conditions and head winds, and not to any fault in the mechanism of the airship. A noteworthy point, however, is the fact that in order to make such a long journey, the crew was cut down to but eight men, so that extra fuel could be carried, and it was in landing to secure more fuel that the accident occurred. The practicability of this airship for carrying passengers on long-distance trips is thus shown to be not very great, as it will be limited to trips of 200 or 300 miles, and as the making of frequent landings to secure more fuel is risky. On the whole, this second German government "Zeppelin" does not seem to be much of an improvement on the first one, which, it will be remembered, was the remodeled "Zeppelin III."

RADIO ACTIVITY AND MINERAL HUES.

INFLUENCE OF RADIUM AND ULTRAVIOLET RAYS UPON THE COLOR OF MINERALS.

BY PROF. C. DOELTER.

MANY minerals, when exposed to radium radiation or ultraviolet light, undergo a change in color. An interesting example of this is kuntzite, a lilac-colored variety of spodumene (a lithium augite of the composition $LiAlS_2O_6$). Under the influence of radium this mineral acquires a green color, similar to that of a natural variety of spodumene known as hiddenite. Ultraviolet light restores the original lilac color, and this color-change can be repeated several times. Kuntzite, which has been rendered colorless by heating at 400 deg. C., very rapidly acquires the bluish-green tint under the influence of radium.

A careful examination of such cases seemed to be of considerable interest, not only for the sake of elucidating the nature of the processes involved, but more particularly on account of its direct bearing on the problem of the causes to which the natural color of certain minerals is due. The author therefore exposed a large number of minerals and also borax glass colored with various metallic oxides, and ordinary glass, to the action of radium. Two specimens of radium preparation were used, of which the one contained 1 gramme of radium chloride, the other one-half gramme. These are the largest quantities ever used by any investigator. One gramme of radium is worth $40,000; in its preparation over two tons of pitchblende are required. Experiments were also made to determine the color changes which occur when a mineral is heated in oxygen, nitrogen, and other gases. As the result of these experiments it was found that some materials were very stable in color, others on the contrary were very readily affected. Most of the so-called idiochromatic substances, whose color is due to their chemical composition, are hardly affected by radium, and undergo a change on heating only if their chemical character is thereby altered. In the case of minerals whose coloration is due to admixture of foreign substances, the latter may be present either in the form of isolated particles of an isomorph (i. e., a substance which crystallizes in the same form as the main mineral), or the coloring matter may be present as it were in a state of solid solution. In the case of materials colored in this way radium, or heating in a gaseous atmosphere, invariably causes a change. Crystals colored by the admixture of isomorphic substances show an intermediate behavior, and are as a rule only very slightly affected, especially by radium. Examples of this kind are the ruby (which is colored by the presence of chromium oxide), emerald, and the tourmalines.

Among the minerals which change color are the sapphire, quartz, fluorspar, and most borax and silicate glasses. There are, however, some borax glasses which are not affected by radium, e. g., titanium, yttrium, and cobalt glasses. The color produced by radium is as a rule the more permanent, the more slowly it has been produced. Minerals rendered colorless by heating, are more rapidly colored by radium than in their original state. This is particularly plain in the case of fluorspar, kuntzite, and hyacinth. On the other hand application of heat destroys the coloration previously produced by radium. This decoloration is usually more rapid in oxygen than in nitrogen. The color produced by radium is not the same if the material is exposed to its action in a glass tube containing oxygen, or in one containing nitrogen. Oxygen in many cases tended to prevent the color-change, while nitrogen had no such effect.

Another point of interest is the action of arc light, which is in all probability due to its ultraviolet rays. Under this influence minerals in their original state undergo little or no change. But if they have been previously colored by radium, they tend, in most cases, to return to their primitive color.

In nearly all instances radium and ultraviolet rays were found to produce contrary effects; an exception to this was apparently the yellow diamond and a specimen of violet glass.

In working up gems, the latter are sometimes heated, in order to obtain the desired hue. It is evidently important to know whether the color-change is due merely to the effect of the heat, or whether it depends on the nature of the surrounding gas. The results hitherto obtained were contradictory. The author has therefore conducted further experiments, which have led to the conclusion that there are two classes of materials. The first class includes smoky quartz and fluorspar. These exhibit no specific action for different gases. In the second class are sapphire, topaz, hyacinth, and emerald. These show a difference in behavior, especially in the speed of the color-change, when heated in different gases.

It is difficult to form any definite conclusion as to the nature of the action of radium. A clue is perhaps given by the fact that oxygen, heating in air at 90 deg. C., and also hydrogen peroxide and ultraviolet rays have an action contrary to that of radium. This seems to indicate that the effect of the radium is to cause ionization, and perhaps the formation of colloidal metal. Whatever the product may be it is very unstable, and destroyed on slight provocation.

Such investigations as that of which an account has been given above may perhaps lead to new technical processes for producing at will various hues in precious stones. Or again, the facts discovered may be found highly useful for distinguishing natural from artificial gems. From the technical standpoint therefore, these experiments are of great interest.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

When metal films are deposited above a certain thickness it is well known that they tend to peel off. Nickel, for example, curls up into beautiful close rolls, especially if it does not adhere tightly to the body upon which it is deposited. This has been found to be a great drawback in producing metallic mirrors by electrolytic deposit on glass. This phenomenon has been recently investigated by Mr. Gerald Stoney, who finds that when nickel is deposited on one side of a thin sheet of metal very considerable bending takes place, indicating that the nickel is in a state of tension, thus confirming some earlier experiments of Dr. E. J. Mills. Thin steel rules 102 millimeters long, 12 millimeters wide, and 0.32 millimeter thick were varnished on one side and coated with nickel from the usual bath of ammonia-sulphate of nickel, and it was found easy to get these to bend to an extent of 3 or 4 millimeters. The thickness of the film was determined by weighing the steel before and after producing the deposit, and thence the tension can be calculated. In the case of films varying from 0.0056 millimeter thick to 0.0264 millimeter thick deposited at ordinary temperature, the tension comes out about 18 or 19 tons weight per square inch. When the deposition is effected at a temperature of 80 deg. or 90 deg. C. the tension falls to about half this value. It was also found on heating these rules to a red heat so as to anneal them that they straightened out to a considerable extent, the remaining deflection being only about one-third or one-half of the original.—Proc. Roy. Soc.

GILDING.

NEW FORMULAS AND PROCESSES.

BY F. HARTMANN.

WET GILDING.

GOLD is one of the most easily reducible metals; that is, it can easily be separated in metallic form from other metals or from oxidizable compounds in solution. There are consequently a great number of methods of gilding by immersion, either at ordinary temperatures or with the use of heat. Gold is very strongly electro-positive, and if brought in contact with a metal which, in relation to it, is electro-negative, as, for instance, copper or zinc, a powerful galvanic current is generated, which hastens the decomposition of the solution in which the gold is present, so that the so-called contact-process of gilding is much more rapid than any other.

The methods which will be described have all the same purpose, that of producing a uniform coating of gold; but the nature of this coating varies with the method. While one fluid produces a fine-grained, dull gilding, another will give a lustrous one, and the advantage of one method or the other is according to the desired purpose. If the fluid is correctly chosen, the object gilded requires no after treatment except rinsing, the necessity of polishing being entirely done away with. But to insure the success of the gilding, the object must be free from any trace of oxides, which is most easily brought about by pickling, before immersion in the gold solution, in concentrated nitric acid, then rinsing quickly in water, and putting at once into the gilding fluid.

Elkington's Method.—In this process, the gilding fluid is prepared as follows: 156 grammes (0.156 part by weight) of gold are dissolved in a mixture of 656 grammes (0.656 part) of nitric acid (1.45 specific weight) and 444 grammes (0.444 part) of hydrochloric acid (1.15 specific weight); the solution is evaporated in the water bath, and the residue of gold chloride is dissolved in water, filtered, to keep back chloride of silver (which is separated from gold which contains silver) diluted with water to make 20 kilogrammes (parts) of fluid, and boiled two hours, after adding 10 kilogrammes (parts) of potassium bichromate.

Instead of the bichromate, which is expensive, experiment has proved that equally favorable results can be obtained with potassium monochlorate, obtained by pouring an equal weight of water over ordinary potash, letting it stand for several hours, filtering the solution and evaporating it to dryness in an iron pan. The residue will be very pure potassium chlorate, and must be put, while warm, into well-closed bottles, since if left in the air, it absorbs moisture, and dissolves.

Copper, brass, or bronze can be gilded by tying the object in brass wire, and immersing it in the boiling fluid. If silver is to be gilded, it is tied up with zinc wire. A large number of small objects, such as articles of jewelry, can be gilded at the same time, by gathering the wires together at the top, and so immersing them. German silver or platinum is treated in the same way. Iron or steel will not hold the gilding well, unless first coated with copper; after being copper-plated, the articles are suspended from zinc wires in the gilding fluid.

Regnault's Gilding Fluid.—The Parisian imitation gold jewelry is made largely by use of the gilding fluid, called Regnault's, which is prepared as follows: 100 grammes (0.100 part) of gold are dissolved in 250 grammes (0.250 part) of nitric acid and 250 (0.250 part) of hydrochloric acid, adding 250 grammes (0.250 part) of water. 3 kilogrammes (3 parts) of simple potassium chlorate are also added, and the solution poured into an iron kettle containing 20 liters (20 parts) of boiling water; and boiled two hours. The composition of Regnault's fluid is similar to that of Elkington's, in fact, almost identical, but the process of gilding is somewhat different.

The objects to be gilded are heated red hot, and pickled, first in dilute sulphuric acid, then for a moment in nitric acid; they are tied together with brass wire, dipped into a mixture of sulphuric, nitric, and hydrochloric acids, quickly lifted out, rinsed, dipped into a solution of mercury and then into water, immersed for thirty seconds in the gold fluid, and, after washing, dried in hot sawdust. If a heavy gold coating is desired, the objects are touched with a zinc rod while in the gold bath.

For coloring the gilded objects, the Regnault process uses a solution of 6 parts of saltpeter, 2 of green vitriol, and 1 of white vitriol, in a little water. The solution is heated to the boiling point, when the objects are immersed and dried at an open fire until they have a brown coating, which is then washed off.

Elsner's Gilding Fluid.—This consists of 1 part of crystallized gold chloride, 5 of salt, 5 of yellow potassium ferrocyanide, and 5 of water. The objects to be gilded are immersed in the fluid, at boiling point, touched with zinc, and are perfectly gilded in three minutes. They are rinsed, and made bright by brushing with moistened powdered tartar.

Castellani's Gilding Fluid.—1 part crystallized gold chloride, 10 parts concentrated hydrochloric acid, 4 parts sulphuric acid, 2 parts boric acid, 150 parts water.

The fluid is used at the boiling point; the objects suspended from a gold wire, touched with a copper rod while in the bath, and dried over a fire.

These are the most important methods for hot gilding, though there are several others, in which gold oxide is produced, and used in caustic alkaline solutions. These fluids, however, are so complicated that they can only be properly prepared by an expert chemist, and they will not be described here in detail, especially as they afford no better results than the simpler ones given above.

The gold coatings obtained by the hot process are always very thin, really only a film, if the object remains but a short time in the bath; if, therefore, the gilding is to be durable, it is recommended to lengthen the time of immersion, and likewise to use contact at the same time.

According to an experiment by Karmarsch, a square meter of tombac had upon it 2.7 to 4.2 grammes of gold; the thickness of the coating was from 1/7100 to 1/4500 of a millimeter. According to Febling, the temperature at which the gilding is done influences the amount of precipitated gold, this being more at higher temperatures. He found that at 15 deg. C. 0.0005 gramme of gold was deposited upon 50 square centimeters of surface; at 100 deg. C., 0.006 gramme. The same fluid was, of course, used for both experiments.

GILDING BY ROLLING.

It would be possible to coat other metals with gold in exactly the same way as with silver; that is, by placing a sheet of copper between two sheets of gold, and passing through rollers until pressed out to the desired thickness. Such filled metal is not to be distinguished, in appearance, from pure gold, and is excellently adapted to the manufacture of inexpensive jewelry, since the layer of gold, though thin, is very dense from the repeated rollings, and is very durable.

But as the coating of gold produced by this method is always heavy enough to make the articles comparatively expensive, another process is substituted for all ordinary purposes, which can also be employed for copper, brass, bronze, iron, or steel.

The object to be plated is first pickled, until perfectly clean, and polished metal must be so strongly corroded that it loses its luster; this is done in the case of copper and bronze with hydrochloric acid, while for iron and steel sulphuric acid is used.

The copper or brass plates are heated until they begin to color, and leaf gold is then applied with a ball of cotton, and immediately pressed on hard with the polishing tool. This process of heating, laying on the gold, and pressing is repeated until the gilding is of the proper thickness; the sheets are then rolled out thin, as the articles made from them, such as jewelry, are usually stamped, and the little dies used would not be strong enough to work on thick sheets.

The so-called rough gilding is made by roughening the plates with a file or scraper, and applying the gold leaf in so thick a layer that the scratches on the plate are not seen, after the gold has been pressed on.

"Talmi" gold, almost exclusively used in the Paris and Vienna workshops for cheap jewelry, is made in this way, with sheet copper, bronze, or tombac; the good reputation for durability which it justly enjoys rests on the fact that the gold layer, though thin, is very firmly pressed on and has been rolled until very dense.

The so-called pure Talmi gold, formerly much in use, was made of gold-colored bronze, plated on both sides with gold, but very thinly. The gold was very dense, and the plating really very durable; but it is no longer produced in this way, the Talmi which appears under that name being now gilded by galvanic processes. It is, however, less durable, as the coating obtained is not so dense.

Parisian Talmi gold consists usually of an alloy of 90 parts copper and 10 parts of zinc, with a gold coating which amounts as a rule to 1 per cent of the weight of a given object.

Plating of Wire with Gold.—Only silver and copper wire are usually plated with gold; the former receives the name of pure or real Leonese gold wire, the former is called imitation Leonese wire.

The so-called pure gold wire is made by plating cylindrical rods of silver. Pure silver must be used, because no alloy of silver would have sufficient tenacity to allow of being drawn out to the required fineness of the wire.

The work is begun by casting a thick silver rod square in cross section in a sand or iron mold; this is beaten into a round shape while hot, and cut in pieces 25 to 50 millimeters in diameter and 50 to 70 centimeters long. These rods are now worked into a cylindrical form by means of a scraper or file, and drawn through a few holes of the wire-drawing plate, to make the little cylinders mathematically exact. Next they are roughened with a file, and leaf gold, rather thick, is pressed on with the polishing tool. After this, the rod is wrapped up in strips of old linen, which are tied around it, and it is heated to a pale red heat in a charcoal fire, whereby the linen covering is burned, and the gold leaf made to adhere firmly to the rod. The last step is working with the polishing tool, and the rod is ready for drawing. It is drawn out into finer and finer wire, which, as the microscope shows, is covered with a close and uniform coating of gold. The thickness of this coating on the finest wire is 1/25000 of a millimeter, and in heavier wire only 1/6000 of a millimeter. The thickness of the finest wire itself is about 0.04 millimeter.

The leaf gold used here, called "factory gold," and universally employed for plating copper and silver, is that which has been beaten out only to a certain degree of thinness. It is 0.075 millimeter in the square, and the thickness varies from 1/140 to 1/250 millimeter. Each leaf averages 0.8 gramme in weight.

The weight of the gold in comparison with the weight of the whole wire varies constantly; in the best wire it amounts to 1/30 of the weight of the silver, but sometimes is as low as 1/130.

The imitation gold wire is made of copper rods, plated in the same way as the silver rods; but as copper is somewhat less ductile than silver, the wire cannot be drawn out so fine. But copper is still very ductile; a copper rod of 18.83 centimeters in length has been drawn out, as an experiment, into nearly 300 kilometers of wire.

Imitation gold wire soon becomes defaced in use, and the red of the copper makes an ugly contrast with the gold color; so that it is desirable to use the pure Leonese gold wire in all cases; the difference in price is only that between the cost of silver or copper rods, as the cost of working is the same. Pure gold wire is used in textile materials and in filigree work; the latter consists of woven wires, which have to be passed through smooth rollers, to flatten them a little. —Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from "Das Verzinnen, Verzinken, etc., der Metalle."

ATMOSPHERIC INFLUENCES CAUSING MOVEMENTS OF THE SOIL.

THE records made by seismographs show that in general the superficial layer of gravel, clay, sand, or other form of loose soil resulting from the disintegration of solid rock is subject to a variety of movements that have no connection with earthquakes properly so called.

Among these microseismic movements many have a meteorological origin; such are the slow tiltings due to the infiltration of rain water, the freezing of the ground, the pressure of the wind against the walls of the buildings, the changes of atmospheric pressure and resulting changes in the weight of the superincumbent atmosphere, the added weight of a mass of freshly fallen rain or snow, the melting of glaciers, and the diminished load on the continent, the changes in level and consequently in the weight and pressure of large interior lakes, the analogous changes in the level and pressure of the ocean water on the seacoasts due to winds and tides.

There are other movements due to strains in the solid rocky substratum or to the relief from strain; these belong to vulcanology and astronomy, and are traceable back to luni-solar tidal strains, to strains due to changes in the rotation of the globe, to volcanic heat and chemical changes, to the changes of aggregation that take place when amorphous strata slowly crystallize under pressure.

The slow tiltings or long tides that are so evident in every seismogram are frequently spoken of as due to the varying load of air, rain, or snow, acting on

the solid rocky shell of our globe; but to me it seems more likely that these tiltings may be due to the influence of changes of load on our superficial soil, 5, 10, or 50 feet in depth, resting on a relatively rigid rocky soil. This soil is permeated with water and air. Like a sponge, it yields to every change of pressure. The water in deep wells, the water-tables, the flow of underground water, are usually found to vary with barometric pressure as plainly as they do with rainfall or melting snow, or freezing temperatures. The explanation of any local tilting phenomenon will not be satisfactory until we have thoroughly studied the influence of atmospheric pressure on the soil and on the ground-water below the seismograph.

The study by Prof. Franklin H. King, of the Agricultural Experiment Station at Madison, Wis., on the behavior of ground water shows how our seismographs are liable to be affected by changes of pressure and the reaction of the air below a wet soil.—Monthly Weather Review.

SCIENCE NOTES.

It not infrequently happens that raw rubber develops an unpleasant "tackiness," the cause of which has been attributed to the action of micro-organisms or of enzymes preventing the coagulation of the latex or milky juice. Though it is possible that such agencies may play a part in the phenomenon, the experiments made by Mr. D. Spence indicate that their effects can only be indirect. The main cause appears to be a change which probably affects only the physical aggregation of the particles. Such changes frequently occur in certain varieties of rubber that have been coagulated with sulphuric acid. In experiments in which two portions of the fresh latex were sterilized by heat and incubated for a month at 35 deg. C., one with and the other without the addition of acid, and the rubber then precipitated, it was found that the product in the preparation of which sulphuric acid had been used was very soft and deficient in strength. These results throw light upon the frequent deterioration of vulcanized rubber, which is injuriously affected to a pronounced extent by the presence of traces of free sulphuric acid.—Knowledge and Scientific News.

The paper read to the Institution of Municipal Engineers by Mr. H. C. H. Shenton is a convenient *résumé* of recent practice in relation to the treatment of water and sewage affluents. Two or three years ago the author put forward the suggestion that sewage affluents could be sterilized efficiently and economically by electrolytic hypochlorite of sodium, a reagent which has been employed with satisfactory results at various places in this country and America. Consequently it is not surprising to find some further notes on the same method in the present paper, which, however, deals adequately with sterilization by ozone, hermite, oxychlorides, sulphate of copper, with and without chlorine and chlorine derived from calcium chloride. A very practical part of the paper is the section where the cost of different sterilization methods is compared. While admitting the practical and economical possibility of sterilization by ozone, Mr. Shenton contends on the basis of experiments conducted at Maidenhead that hypochlorite sterilization would be far less costly and equally efficacious. This is a point on which more information is to be desired.

An important memorandum with regard to an international standard of light has just been published. It is satisfactory to learn that France, America, and England have come definitely into line and have agreed to adopt the same standard "candle." Seeing that the differences between the units in these various countries were only of the order of 1 or 2 per cent, it would have been very humiliating if national jealousies had prevented a common agreement. Luckily the standards of light in use in France and England were known to be affected by certain errors due to the amount of moisture in the air, and so the true value of the "candle" or the *bougie décimale* could not be rigorously obtained. Some years ago the American Bureau of Standards adopted the English candle as their standard. They found out, however, that the value of this unit was more or less undetermined. Perhaps it was their threat to set up an American candle that induced the commissioners to agree to sink their differences. The "Hefner," the standard used in Germany, has an appreciably smaller value than the candles used in other countries, and so it would have caused considerable commercial inconvenience to change the standard in that country. Still, as eleven Hefner candles are defined to be exactly equal to ten international candles, it is easy to convert from one unit to another. Remembering, however, that Germany occupies the leading position in the lamp manufacturing industry, it is probable that it will not be a disadvantage for it to have a low standard. The average consumer will naturally infer that a German lamp giving 55 *kersen* for a given current is superior to a French or English lamp giving 50 *bougies* or candles for the same current, although as a matter of fact the light they give will be identical if they have been truly rated.

ENGINEERING NOTES.

Mr. A. Mallock, F. R. S., exhibited before the Royal Society an engine worked by stretched India rubber. This model is intended to illustrate a method whereby a long stretched India rubber cord can be made to produce mechanical work. The stretched cord is wound on a reel, and it is essential, if the conversion of potential into kinetic energy is to be efficient, that no change of tension in the cord should occur while it is being unwound. This necessarily demands that the process of conversion should follow a cycle, in one part of which the cord is unwound at constant tension, and in the other part the unwound cord is allowed to contract. In the model this cycle is carried out automatically by the mechanism.

Experience in burning coals from all sections of the country in a hand-fired furnace indicates that for such an equipment (see United States Geological Survey Bulletin) the size of the coal is not of as much importance as is usually thought to be the case, but the smaller sizes require more draft and are slightly less efficient. Nor does the ash affect the results as much as might be expected. Small variations in the percentage of ash seem to have but little effect, except in so far as the heating value of the coal is varied. Owing to the fact that the moisture, ash, and volatile matter usually increase together in the poorer coals, it is difficult to separate the effects of any one of them from the other.

In a paper upon manganese steel presented before the Western Society of Engineers it is pointed out in connection with its magnetic properties that a bar of manganese steel balanced on a knife edge remains in balance when acted upon by the field of a very powerful electromagnet. An electromagnet which would lift two tons of soft steel, when laid upon a block of manganese steel gives so small a pull that the hand recognizes no increased weight in lifting the magnet. A coil passing a current and acting as a solenoid on a bar of manganese steel develops no magnetic quality. Very thin cuttings of manganese steel are not lifted by a strong magnet, but if these cuttings are hammered into very thin foil they may then be lifted by the magnet. From these considerations it would appear that this steel might be used to advantage about motors and generators, in a crankshaft, for example.

A bulletin on the smokeless combustion of coal in boiler plants, with a chapter on central heating plants, will soon be issued by the United States Geological Survey, Technologic Branch, giving in detail a study of the conditions found in industrial establishments in thirteen of the largest cities of Indiana, Illinois, Kentucky, Maryland, Michigan, Missouri, New York, Ohio, and Pennsylvania, between 400 and 500 plants having been inspected. Sufficient information was collected to make the data from 284 plants of value for this report. The bulletin, prepared by D. T. Randal and H. W. Weeks, not only shows that bituminous coals high in volatile matter can be burned without smoke, but also that large plants carrying loads that fluctuate widely, where boilers over banked fires must be put into service quickly and fires forced to the capacity of their units, can be operated without producing smoke that is objectionable. Proper equipment, efficient labor and intelligent supervision are the necessary factors.

It is expected that the great transcontinental railway of South America, extending across the Andes from Chile to Argentina, will be completed in June, 1910. This railway will be one of the greatest engineering works in the world. The Chilean part bristled with difficulties, especially in the still unfinished section between Juncal and the Argentine frontier. The line crosses the Cumbre pass at an elevation of 12,600 feet, after traversing a spiral tunnel nearly two miles long, the mouth of which is at an altitude of 10,400 feet and on a slope of 75 per 1,000. Still greater altitudes are attained by other South American railways, which are the highest in the world. The line connecting La Paz, Bolivia, with Arica, Peru, the construction of which is to be commenced at once, will rise at Incara to an altitude of 13,350 feet, and the existing line between La Paz and Antofagasta, Chile, crosses the Ascotan pass at an elevation of more than 13,000 feet. Another line crosses from Peru to Bolivia at a height of 14,600 feet. Finally, the Peruvian railway from Callao and Lima to the silver mines of Cerro de Pasco, traverses a tunnel 15,850 feet above sea level.

In a paper read to the Society of Chemical Industry Mr. G. N. Huntly referred to the investigation made into the cause of corrosion in the plates of steam boilers at the generating station of the London Electric Supply Corporation. The inquiry made clear the fact that the presence of sulphur as a constituent of steel is a factor that must be taken into account. It was formerly supposed that, provided the sulphur in steel was completely combined as, for instance, in the form of manganese sulphide, its injurious effects on the metal would be negligible. That, however, is now recognized as a fallacy—a point demonstrated by the investigation described by Mr. Huntly, as well as by recent metallographic evidence. The lesson is one which ought not to escape the notice of architects and engineers engaged in the design of structural work, where corrosion of internal origin is quite as undesirable as corrosion due to external causes. We have alluded on various occasions to the injurious action of sulphur in aggregates sometimes employed injudiciously for making concrete to be applied around steel in structures. If thoroughly combined sulphur is so serious an enemy to steel it is reasonable to argue that sulphur in less inert forms must be far more hostile.

TRADE NOTES AND FORMULÆ.

Indestructible black ink is made from 1 part lampblack, 12 parts potash water-glass of syrupy consistency, 1 part fluid ammonia, and 38 parts of distilled water.

Waterproof Wax Finish for Carriage Covers.—Melt 6.35 parts of carnauba wax, dissolve in it 0.57 part stearate of alumina, add 25.40 parts each of dark mineral oil and cotton oil and 6.35 parts of bone black, stir well together and add, when somewhat cooled, 25.40 parts of rosin spirit.

Artificial Vanilla Essence.—3.75 parts of Peruvian balsam and 1.75 parts of oil of orange are rubbed down with 250 parts of rectified alcohol and 10 parts of magnesia, 125 parts of essence of orris root, 62 parts of Tonka beans, and 30 drops of tincture of castoreum mixed in. The whole is allowed to stand for four weeks in a warm place and it is then colored with caramel and filtered.

Jackmann's Washing Powder (a substitute for bleaching fluids). I. 3 parts of crystallized soda and half a part of borax are dissolved in 4 parts of boiling water. After cooling, dissolve ¼ part of carbonate of potash in it and then add 1/5 part of ammonia. II. On 1 part of quicklime pour 4 parts of boiling water, stir it well and allow to settle. The clear lime-water is then mixed with the above solution. The lime in solution converts a corresponding quantity of the soda and this forms a weak solution of caustic soda.

Belt Preservative.—In a closely-covered iron pot, heat to a temperature of 120 deg. F. 10 parts of caoutchouc, cut into small pieces, and 1,000 parts rectified oil of turpentine. When the caoutchouc is dissolved, add 8 parts of rosin, stir until it has all melted, and then add 8 parts of yellow wax to the mixture. In another suitably large pot place 30 parts of train oil and 10 parts of tallow, heat the mixture until the tallow is melted and pour in the melted mass from the first pot, stirring constantly until the mixture cools and solidifies. The belts, while in use, are rubbed with this preparation from time to time on the inside; a greater durability is thereby imparted to them, they run easily on the pulleys without slipping. Even old, badly worn belts may be improved by the dressing. It should in this case be applied to both sides, an operation that should be conducted in a warm place; allow the first coat to soak in and coat it again with the same preparation. The belts thereby attain greatly increased wearing power and may be used for a longer time than otherwise.

Washing Cream.—I. 320 parts first quality white soft soap, 80 parts pulverized castile soap, and 20 parts oil of sesame are well purified and perfumed with 5 parts of lemon-peel oil. II. 250 parts of potash soft soap, 120 parts best soda soap, 60 parts each olive oil and water, 7 parts potash. III. 60 parts oil soap, 30 parts dry soap powder, 15 parts honey and rose water, as much as necessary to obtain a fine foaming product. IV. 8 parts lard and 2 parts cocoanut oil are saponified in the water bath, with 4½ parts of 40 per cent potash lye, colored pink and scented with rosewood oil and with oil of bergamot. V. 30 parts of the best lard and 6 parts oil of sesame are melted together and to this fat, at a temperature of 100 deg. F., 3 parts of 40 per cent caustic potash lye, previously mixed with 1 part of water, is added in a thin stream; after which 14 parts of 40 per cent caustic potash lye are stirred in, in the same manner. The soap mass is then heated in a water bath of moderate temperature, in which, while stirring, complete saponification is effected.

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